ENGINEERING 11-10-57

ENGINEERING

An Illustrated Weekly Journal

35 & 36 BEDFORD STREET, STRAND, LONDON, W.C.2 - - TELEPHONE: TEMPLE BAR 3663

Vol. 184 No. 4779 *LONDON, FRIDAY, OCTOBER* 11, 1957 PRICE 2s.

DE-OILING BEARING RINGS

Nurnberg photograph for ENGINEERING

OCTOBER 11, 1957 VOL. 184 PAGES 449–480

ENGINEERING

An Illustrated Weekly Journal

Vol. 184 No. 4779 OCTOBER 11, 1957

Leading Article
Evolution of Sports Cars 449

Plain Words 450

Special Articles
Railway Modernisation—Diesel Traction is Coming in Fast 450
Satellites and Technical Leadership 455

Letters to the Editor
Overtime at Home 453
Sewing Machines 453
"Propellant" and the O.E.D. 453
Distinguishable Figures 453
Distinguishable Ideals 453

Companies in the News 454

Book Reviews
Flood of Books on Automation: A Guide 470

On the Shelf 471

Atomic Review
Fusion Hot and Cold 474

Automobile Engineering
The French Motor Industry 476
New Vauxhall Sixes 477

Notices of Meetings 478

Metals and Materials
Plastics Bonded to Steel 456
Tube Investments and Aluminium 457
Buried Copper Tubes 457
Aluminium Tread Plates 457
Instruction in Steel Metallography 457
Costing for Non-Ferrous Metals 457
Covered Electrodes: Welding Mild Steel 457

Plant and Equipment
R.M.S. Queen Mary's Fuel System: New High-Pressure Units Installed 458
Thermometer for Hypothermia 459
Industrial Diesel Shunting Locomotive 459
High-Discharge Overloader 459
Simplified Speed Change on a Drilling Machine 459

Management
How Good are Soviet Engineers ?: 5—How the Soviet Engineer Practises Management 460
Weekly Survey 462

Marketing 463

Research and Development
Materials and Microwaves: Extensive Programme at Mullard Research Laboratories 464
Advances in Aeronautics 465

Design
De-Salting Brackish Water for Drinking 468
Stepless Speed Reducer 469
One-Way Clutch 469
Electric Siren 469

Production
Faster Work in the Fabricating Department 472
Launching by Rolling 472
1958 Census of Production 472
Production of Gear Hobbers: New Factory for Churchill Gear Machines 473

Construction
Planned for Expansion 477
Cross-Channel Cable Approved 478
Revolution on the Landing Strip? 478

The Human Element 479

Published every Friday by Engineering Limited, 35 & 36 *Bedford Street, Strand, London, W.C.2.* TELEGRAPHIC ADDRESS *Engineering, Lesquare, London* TELEPHONE *Temple Bar* 3663

Subscription Rates: 12 *months, Inland and Abroad* £5 10*s., Canada* £5 5*s.; 3 months,* 27*s.* 6*d. all countries. Single copies,* 2*s.* 7*d. post free.*

EVOLUTION OF SPORTS CARS

HEAVY taxation and very high insurance premiums may have crippled the British sports car market, but sports cars account for an important proportion of British vehicle exports. The four international motor shows this autumn—in Frankfürt, Paris, London and Turin—show that this class of vehicle is in a state of intensive development. Britain opened up the market, particularly on the West Coast of the United States, with a range of cheap reliable sports cars made largely from standard components already in production for touring models, and these still sell in significant numbers. Power has been increased and brakes have been improved, but there are signs that this type is reaching the limit of its possibilities.

A sports car should be able to compete in sporting events with some hope of success, but these simple low-cost cars are no longer able to compete with special racing machines. Racing being ruled out, there is little point in putting up with the discomfort of simple open bodywork, except in climates such as that of California, where it has obvious attractions. For rallies, a closed car is eminently suitable, and if weight reduction is sufficiently studied it can also race successfully—a fact exploited notably by Porsche, who in markets like Switzerland have been able to sell at least as many cars as M.G. and at twice the price. Efforts have been made to compromise by fitting detachable hard tops, but the result is too often a cramped and leaky vehicle. In British production the true small sports coupé represented by the Porsche and Alfa Giulietta is a notable absentee, leaving a gap which the new Peerless, with Triumph engine, is designed to fill. The M.G. coupé, with proper side windows, comes near to meeting the need, but it is strictly a two-seater and has very little luggage space. Among the larger cars, the popularity of the Jaguar coupé must have been restricted by its open-car ancestry until the advent of the latest model which has much more interior space. It is significant that at present the Jaguar range contains no open two-seater; the XK-SS is not yet being made, and no successor to the XK 140 two-seater has been announced.

American manufacturers, impressed by the success of imported sports cars on their own doorstep, have entered the market but with cars of sporting appearance designed to appeal to those who like to go to motor races but do not intend to compete. The Chevrolet Corvette, the Ford Thunderbird, the Studebaker Hawk range (including one supercharged model) and now the Packard Hawks, are all cars of sporting type with a large measure of comfort and luggage space, equipped with heaters, radio and automatic transmissions if desired. In some cases the range selector lever for the automatic transmission takes the form of a central gear lever, to add to the illusion. It seems likely that this market will eventually be much larger than that for the pure sports car, and European manufacturers are energetically catering for it, with very well finished coupés and convertibles, using stock engines suitably modified for higher power output. The Karmann Ghia Volkswagen coupé, which had a great success despite its limited performance and restricted road holding qualities, is now supplemented by a convertible. Auto Union have a three-cylinder two-stroke front-drive coupé looking like a scaled-down Ford Thunderbird, and Goliath also use front drive, with a flat-four engine for a nicely finished 1,100 c.c. two-seater coupé priced to compete directly with the Ghia Volkswagen, while the front-engine rear-drive 1,500 c.c. Borgward Isabella from the same group is now available as fixed-head coupé or convertible.

But quite apart from the question of bodywork, it is noteworthy that all these Continental models have independent rear suspension, or a rear axle located by some means more precise than the master leaf of a half-elliptic spring. British engines and brakes are good and inexpensive but it is time British engineers gave more attention to the design of their chassis. Even the Jaguar, which is virtually invincible on the billard table surface of Le Mans, is quite unable to keep up with smaller-engined cars on the Nurburgring, or even on a tricky circuit like Aintree at home. Under the impetus of competition, tremendous strides are now being made in performance, road holding and cornering. In the recent Tour de France, a Mercedes-Benz 300 SL coupé, although brilliantly driven by Stirling Moss, could only finish fourth against the Gran Turismo Ferraris, yet only two or three years ago this was widely regarded as an almost unbeatable competition car.

In the smaller classes, British designers have produced competition machines which are at present unbeatable, but as yet their success is not reflected in the design of the commercial models in large-scale production. So far, the low-priced sports car has proved a lucrative by-product of touring car production for some of the big manufacturers, but this phase may be drawing to an end. Manufacturers may yet find it a better long-term investment to use their sports cars as a means of initiating chassis improvements which will benefit future touring cars. This is the policy which has been followed by Mercedes and to some degree by Panhard.

Cover Picture. *The steel outer and inner rings for ball and roller bearings are hardened by heating them to a temperature of 850 deg. C. and quenching them in oil. The picture shows the rings entering the de-oiling apparatus on a gravity roller conveyor. The solution employed for cleaning the rings is maintained at a high temperature to ensure that the rings are thoroughly de-oiled prior to the tempering treatment.*

* * *

Plain Words

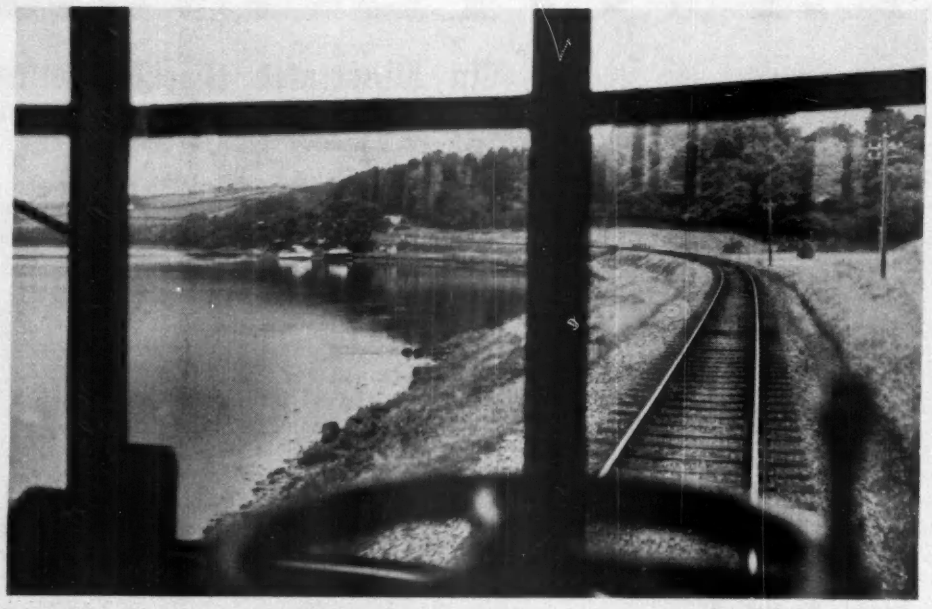
We encountered a few days ago an engineer who is the personification of Plain Words. It was evident that he took pride in refusing to toe the contemporary line; he preferred his opinions to be based on his own common sense and experience rather than on the current theories and fads. His comment on modern management teaching was typical: he contrasted the traditional idea of a good manager as one who had his finger on the pulse and directed the organisation by sheer force of personality, with the present idea that good management is becoming more and more the art of organising affairs so that the manager himself is less and less necessary —a conception of management which he found vastly comic.

The truth about such a complex and varying function as management cannot be expressed by an extreme, sweeping generalisation, however much one may wish for simplification. A healthy cynicism for theory applied to what is, after all, a very practical job cannot deny the revolution which has taken place. Before the first World War the manager had a relatively easy time. He directed employees who were highly disciplined, who could be punished for mistakes and carelessness, and he was not troubled by the growth of specialised knowledge and techniques which has since taken place. Trade unions had not yet come to participate in management. To-day, the manager who tries to emulate the Victorian approach of his grandfather soon finds that he himself is punished.

The whole trend of progress in production methods has been to reduce the significance of the human element. But other factors have arisen to render the human element even more significant than it was in the past. At the same time the trend towards large organisations, commercial and State, has created a situation where most managers have no option but to learn the art of delegation since it would be quite impossible for them to exercise effective control otherwise.

But something of the old spirit must not be lost. A dynamic outlook at the top will permeate throughout all levels of an organisation. Look around at the enterprises which have flourished since the second World War and it is easy to pick out the individual leaders who have made things hum. Like their Victorian predecessors they have exerted a powerful influence on those under them; but with this difference—that they have been sympathetic to the changed social and political climate. They have not tried to swim against the stream.

RAILWAY MODERNISATION —



The multiple-unit Diesel train heralded the modernisation plan. The introduction has proved equally successful on both suburban and, as at Tal-y-Cafn here, local branches.

Running into Rugby behind a main-line Diesel-electric locomotive, then visiting the refreshment bar in which all traces of descent from Dickens' Mugby Junction refreshment room have been obliterated, the traveller sees the plan for modernisation and re-equipment of British Railways becoming a reality. A few miles away a country junction and a two-coach local train with steam up for a branch line remind him of how much has to be done. A medley of period styles can be observed in any main-line journey—in station buildings, signals and signal boxes, locomotives and rolling stock—and often it is the modern that seems out of place. One well-intentioned but not entirely successful experiment in modernisation has been to install so-called "contemporary" lighting fittings and tubular-framed chairs in a certain cavernous waiting room where the eye instinctively seeks a gas mantle and horse-hair benches. Clashes of this kind will be hard to avoid in the early stages of observing the dictum in the modernisation plan that "an improved quality of train service may fail to make its proper impact on the public if the standards of accommodation and amenities provided at passenger stations lag behind."

So far, the results of the £1,200 million modernisation plan for British Railways are probably most apparent to the public in areas where large-scale replacement of steam trains by Diesel cars has taken place. This process actually originated before the plan was published, and its course to date is outlined below.

LIGHTWEIGHT DIESEL TRAINS

In 1952 a committee which had been appointed a year earlier by the Railway Executive to consider and report on the future use of Diesel lightweight trains, presented its conclusions and recommended four areas as particularly suitable for service of this type. The four areas were: Lincolnshire; West Riding of Yorkshire; Newcastle, Carlisle, Edinburgh and West Cumberland; and East Anglia.

The first of these schemes to come into operation was that in the West Riding, where eight two-car sets were introduced in the summer of 1954 on the routes between Leeds, Bradford, Harrogate, Knaresborough and Castleford. These lines are steeply graded, and trains were therefore formed of two motor cars, each powered by two 138 b.h.p. Diesel engines mounted on the underframe and driving the inner axles of the four-wheel bogies through hydraulic torque converters. This West Riding service was followed in November of the same year by the first Diesel trains in Cumberland on the London Midland Region line between Carlisle and Silloth. In this case the formation consisted of a motor car and trailer. On February 7, 1955, the West Cumberland scheme was completed by the inauguration of Diesel trains between Carlisle, Maryport, Workington and Whitehaven.

The modernisation plan, published in January, 1955, accepted that, where traffic was within their capacity, a considerable increase in net revenue could be secured from the replacement of steam services by Diesel-powered trains, ranging from single units to six-coach sets. A target of 4,600 Diesel cars and trailers was envisaged. By the end of this year about 1,450 will be in service and upwards of 2,700 by the end of 1958.

Various combinations of motor cars and trailers can be used to make up different lengths of train, but the usual arrangements are a two-car set (two motor cars or a motor car and trailer), a three-car set (two motor cars and intermediate trailer), or a four-car set (two motor cars with two intermediate trailers). The first Diesel trains to be operated regularly as four-car sets were those for the Newcastle-Middlesbrough service introduced in November, 1955.

Two motor cars have been adapted by the provision of driving compartments at both ends for single-unit working on the Banbury-Buckingham branch of the London Midland Region, where the steam service had latterly involved a loss of £14,000 a year. This was a first step towards implementing the recommendation of the Central Transport Consultative Committee that simpler four-wheel vehicles operated by a driver-conductor should be used on lines where the traffic is too light to justify a standard type of bogie railcar. It was announced last May that 22 lightweight railbuses have been ordered from five firms, including one German, for delivery this year and next.

The four-wheel Diesel railcar is not entirely new to this country, for a three-car train composed of two four-wheel 125 h.p. motor cars and a trailer was demonstrated in 1952 and later ran experimentally in various parts of the London Midland Region. At present trains of this type are working on the Watford Junction-St. Albans branch.

Last year saw Diesel railcar trains introduced

— DIESEL TRACTION IS COMING IN FAST

for local services over large areas, sometimes replacing steam traction completely except for certain through services and goods trains. Norwich, for example, became a focal point for services radiating over the main line to Ipswich and Yarmouth, and over the cross-country routes to Dereham and Wells, and to Cromer, Sheringham and Holt. North Wales received its first Diesels for the Llandudno-Blaenau Festiniog line, and a few months later they were operating from Bangor to Amlwch in Anglesey. A large Diesel programme began in Lincolnshire, also. Busier centres similarly saw the introduction of Diesel services on lines with a good traffic potential but on which it had been uneconomic to provide a steam service competitive with other forms of transport. Examples are Birmingham to Sutton Coldfield and Lichfield, Manchester and Rochdale to Bury, and Bury to Bacup. Extensions of these services have continued in the present year and on some established routes the frequency of railcar trains has been increased. In the current winter timetable nearly one-third of the train-mileage in the Eastern Region is being run by Diesel or electric power. Another route served for the first time by lightweight Diesel trains, as shown in the current timetable, is that from Crewe to Stoke and Derby. The new three-car sets for this service are the first of their type on British Railways to have intercommunication between all vehicles. Accelerated journeys and regular-interval departures for most of the day should stimulate passenger traffic on a section where the steam train, like Goldsmith's traveller, has tended to be "remote, unfriended, melancholy, Slow."

But the modernisation plan had put fast city-to-city express services first in the list of appropriate Diesel facilities. Scotland was the first to see them, when six-car Diesel sets began to operate certain workings between Edinburgh and Glasgow on January 7 this year. In these trains the basic unit consists of three cars—motor car, trailer and motor car, giving four motor cars, or 1,200 h.p. per train, the two engines in each motor car being rated at 150 h.p. In the two adjacent intermediate motor cars the driving compartments occupy only part of the body width so as to leave room for an end vestibule and gangway connection. One trailer in each six-car train has a buffet compartment, from which an afternoon tea service can be given to all seats in the train. Similar trains were built for the Birmingham-Cardiff-Swansea service in the Western Region which was inaugurated with the summer timetable this year and has been extended to Carmarthen.

One of the most-quoted remarks in the modernisation plan has been that relating to the improvement of permanent way to permit speeds up to at least 100 m.p.h. The inter-city Diesels mentioned above are not intended for speeds of this order, their maximum being 75 m.p.h., but there is no doubt that public expectations have been raised and that the demand exists for fast business services with a "new look" in motive power and accommodation. The high-speed de luxe all-Pullman Diesel-electric sets ordered earlier this year will be concrete evidence that the plan is moving in the expected direction. Five of these trains are being built, two being six-car first-class only sets for the St. Pancras-Manchester Central service in the London Midland Region, while three will be eight-car sets with first and second class accommodation for the Paddington-Bristol and Paddington-Birmingham-Wolverhampton services in the Western Region.

The two power cars in each train will be equipped with 1,000 h.p. Diesel engines driving generators supplying eight traction motors distributed between the power cars and the other vehicles. All the trains will be air-conditioned and will have heat and sound insulation, the passenger portion of all vehicles being fully enclosed, with double-glazed windows. Meals

Multiple-unit Diesel and Diesel-electric sets are already running on the routes shown. De-luxe services from London to Manchester, Bristol and Wolverhampton will start next year.

will be served at all seats. A 177 h.p. Diesel engine and alternator on the underframe of each power car will supply auxiliary services. The normal maximum service speed will be 90 m.p.h. and it is planned to put the first of the trains into service in 1958.

This year has seen the introduction of Diesel-electric trains on the Southern Region between London and Hastings via Tonbridge. In the last days of the Southern Railway this route was scheduled for electrification, but the work did not proceed, and soon after the modernisation plan was published the Southern Region announced that Diesel-electric trains were to be introduced. Originally planned for the current summer service, the first of the trains actually went into traffic on May 6 in replacement of steam workings which could not be handled at Cannon Street because of operating difficulties caused by the signal box fire at that station on April 5. These six-car units, each with two 500 h.p. engine-generator sets, were described in the May 10 issue of ENGINEERING. They may be regarded as an adaptation of standard Southern electric stock to suit the loading gauge limitations of tunnels on the Hastings line, and carrying their own generating plant instead of collecting current from a live rail. Some generally similar two-car units (500 h.p. motor car and trailer) began operating on the Portsmouth - Southampton - Salisbury; Portsmouth - Romsey - Andover, and Alton-Winchester-Southampton routes in the current winter service.

DIESEL MAIN-LINE LOCOMOTIVES

Multiple-unit traction with Diesel power up to the present has far outstripped the progress of Diesel locomotive haulage in this country. Both the L.M.S.R. and the Southern Railway announced orders for main-line Diesels on the eve of nationalisation and the two London Midland Co-Co 1,600 h.p. units have been

Lightweight cars on the Crewe-Stoke-Derby service, introduced this winter, with intercommunication between all vehicles. They have 150 h.p. engines.

running since 1947. A Bo-Bo of 827 h.p. for mixed traffic was also built for this Region, appearing in 1950. The Southern Region design was a 1Co-Co1, the first two, rated at 1,750 h.p., coming out in 1951, and a third, with a rating of 2,000 h.p., in 1954. In 1955 these locomotives were joined by the contractor-built "Deltic," which develops 3,300 h.p. for a weight of 106 tons. All these designs used electric transmission, but a single 2,000 h.p. Diesel-mechanical locomotive using the Fell system, with four 500 h.p. engines driving through fluid couplings to a common gearbox, began running on the London Midland Region in 1951.

These were the "handful of prototypes" referred to in the modernisation plan, which aimed at a complete changeover from steam to Diesel traction in specified areas for which electrification was not at first proposed. Two schemes named, requiring between them some 200 main-line Diesel locomotives, were for the Western Region beyond Newton Abbot, and for the West of England and Bournemouth and Weymouth main lines of the Southern Region from Waterloo. Towards the end of 1955 orders were announced for 174 main-line Diesel locomotives the first of which are now being completed. They fall into three categories, known as Type A (800-1,000 h.p. for freight), Type B (1,000-1,250 h.p., for mixed traffic), and Type C (2,000 h.p. or over, for heavy duties). In the present year, 23 of Type A, 8 of Type B, and 18 of Type C are scheduled for construction. These include 6 of Type B and 5 of Type C with hydraulic transmission, together with 3 of Type C having a combination of fluid-coupling and self-changing mechanical gearbox. All other main-line units on order are Diesel-electric. The first Diesel-electric locomotive of Type A was handed over to British Railways in June (see ENGINEERING, issue of June 28, page 824), and in the same month 46 more complete Diesel-electrics of Type B were ordered, together with 10 sets of power equipment for installation in locomotives to be built by British Railways.

DIESEL SHUNTING LOCOMOTIVES

The first major programme of Diesel shunter construction was announced in 1951, when it was stated that 573 additional units were to be built. About 550 are now in service and it is expected that a further 500 shunters will be delivered this year and next. The standard 350 h.p. Diesel-electric 0-6-0 type predominates, and orders for 546 more power equipments for these units were announced in September, but Diesel-mechanical and Diesel-hydraulic types of 150 to 350 h.p. with the 0-4-0 and 0-6-0 wheel arrangements are also being built. Since nationalisation the number of Diesel-electric shunting locomotives added to the stock has been 306, and of other types 153 (figures are for May this year).

PROTOTYPE PROBLEM

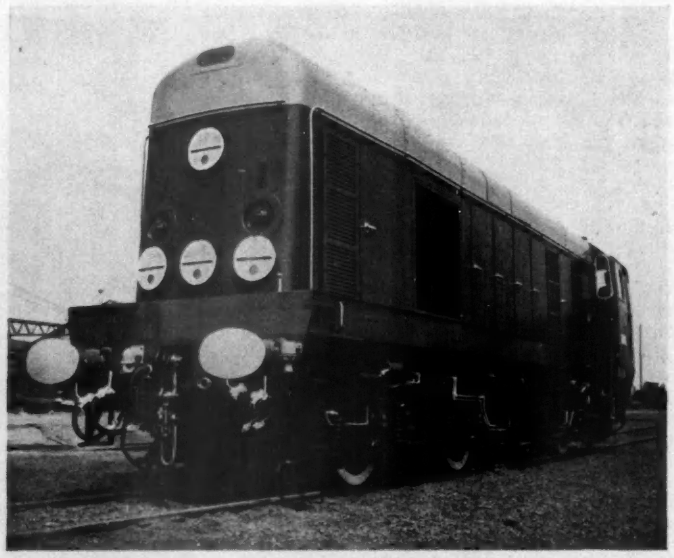
When it is considered that the modernisation plan announced the intention to build no new passenger or express steam locomotives after the 1956 programme, it is almost alarming to realise what lies ahead in proving and selecting replacements for steam from the numerous Diesel-electric main-line prototypes now being built, in which seven engine builders, six manufacturers of electrical equipment and two forms of hydraulic transmission are concerned. It is certainly a dramatic switch from six main-line Diesel locomotives introduced at intervals over a period of seven years to a programme of building 174 in some three years, but it has often been urged that for a true picture of the economics of Diesel traction to be obtained, timetables must be planned so that the locomotives are fully utilised. This has not been possible with the handful of locomotives running up till now.

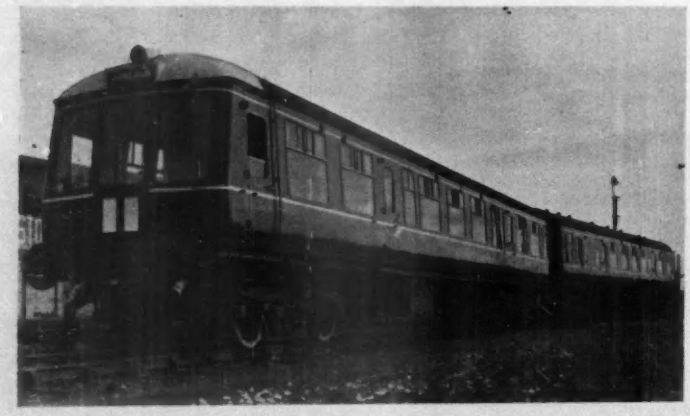
In shunting locomotives, the design of the standard 350 h.p. Diesel-electric unit appears to have been stabilised. Minor variations, such as the use of a two-stroke engine and a special exciter system for the main generator instead of resistance control, have appeared in small numbers but have not been continued in recent orders. A possible development is a modified gear ratio in units to be built in future to provide a top speed suitable for inter-yard working of goods trains. Conversion of trip working of this kind from steam to Diesel power, together with all shunting, was estimated in the modernisation plan to be completed in 15 years.

Railcar design has adhered to the principle of two engines, hitherto generally of 150 h.p., per motor car with fluid flywheels and epicyclic gearboxes, and electro-pneumatic control of engines and gears to allow two or more motor cars to be controlled simultaneously. Torque-converters are used instead of mechanical gearboxes in some units, including a two-car set in which the motor car is powered by two 238 h.p. engines and direct drive comes into action automatically at higher road speeds. New engines of 185 h.p. and 230 h.p. are also being incorporated in recent vehicles or supplied for the trial conversion of existing stock with 150 h.p. engines. The motor car of one two-car unit has been equipped with an automatic gearbox. One set, which is powered by two 230 h.p. engines, has recently gone into service in the Eastern Region. The controls are similar to those in the 150 h.p. units, and provision has been made for both types to run together as a single train. Where this stock has been built by contractors, variations in interior layout and fittings have been made, and the somewhat austere interior aspect of the earlier vehicles has been modified by the choice of colour and materials to produce pleasing and spacious effects. In certain recent vehicles weight reduction has been achieved by all-welded box-girder construction of the bodies, using steel or aluminium tubular members and dispensing with the conventional separate underframe.

Surprising increases in traffic have been reported after the introduction of railcar services, probably much influenced by novelty in the early days. In the long run the success of a Diesel programme depends on efficient maintenance and a general standard of knowledge among all concerned with the vehicles sufficient to enable minor troubles to be recognised and rectified. Unfamiliarity may lead to a railcar or locomotive being declared unserviceable by its crew when all that has occurred is a fault in manipulation. Schemes are already being developed to meet these requirements, such as the new Eastern

(Right) The first of the Class A 1,000 h.p. Diesel-electric freight locomotives is now in service on the London Midland Region.





(Above) The new two-car trains on the Eastern Region have 230 h.p. engines and use the standard fluid-coupling epicyclic gearbox drive.

Region training school for Diesel train drivers at Hadley Wood, where men receive a two weeks' course of lectures and practical work; and extensions at Derby Works training school, London Midland Region, to increase courses from 90 to 120 trainees at a time. The training of suitably-qualified engineering graduates entering the railway industry has been concentrated under a scheme announced by the British Transport Commission in 1955 so that men may complete their courses in two years instead of three. (See page 462 of this issue.)

These developments in training have been accompanied by the extension of Diesel repair and test facilities at locomotive works, as at Derby and Doncaster, and the provision of new maintenance depots at centres, such as Norwich, from which numbers of railcar services radiate.

Further articles will review other aspects of modernisation.

Letters to the Editor

OVERTIME AT HOME

SIR, How true are the words of Mr. Francis B. Willmott in your issue of August 9 (page 165) regarding overtime at home. Many of us in senior positions also do overtime at work and, due to our ridiculous methods of taxation, those of us purchasing our houses are in a bad way relative to the hourly-paid worker who largely lives in a Council house, heavily subsidised by us.

I can only say how sick and tired I get of doing the various tradesmen's jobs on the house, alternating with the maintenance of the car. How nice it would be just to take the wife out in the car for a meal at weekends instead of this constant round of repairs which one cannot afford to have done. So far as one can see, the only good point in the three weeks' holiday scheme some firms are operating, is that it is an opportunity to paint the house! I am quite sure no one in the middle income group can afford to have a three weeks' holiday, as is shown by the number of them who find it necessary to have even two weeks on the cheap by renting a caravan or cottage.

What is needed in firms is a staff profit-sharing scheme to offset the horrid flatness of a fixed income and also a perquisite officer, whose job would be to make life easier for the senior staff by the many ways which can be connived at within the law.

Yours faithfully,

F. GREAVES.

29 Whitaker-road,
Derby.
October 2, 1957.

Editor's Note: The Plain Words to which the above letter and that of Mr. Willmott refer appeared in ENGINEERING for July 19, page 66.

★ ★ ★

SEWING MACHINES

SIR, We wish to refer to your issue of August 23, on page 233 of which you published a very good and accurate article concerning our company and certain aspects of the sewing-machine economy in general. May we, however, mention that the Necchi Company (which, in January, 1957, changed its name from Vittorio Necchi S.p.A. into Necchi S.p.A.) was not founded as late as 1947? As a foundry, the company has been operating for over a century and it began manufacturing sewing machines in 1919. What actually started in 1947 was the introduction of Necchi machines into the United States market.

As regards United States imports of sewing machines it should be noted that the 1956 imports (which according to your article totalled 1·4 million units) included 408,000 machines of less than 10 dols. value per unit, that is, they were mainly baby-machines for children, imported from Germany and Japan. This factor also accounts for the rather surprising figure of 288,000 machines imported into the United States from West Germany in the year 1954 (as you quote on page 234). With an average total annual production by Germany of 600,000 domestic sewing machines, 50 per cent. of which are exported, it is impossible that 288,000 "real" sewing machines could have been shipped to the United States alone.

In our opinion, reference should also have been made to Gritzner-Kayser, Karlsruhe; Kochs-Adler Werke, Bielefeld; Anker-Werke, Bielefeld; Phoenix, Bär & Rempel, Bielefeld; Duerkopp-Werke, Bielefeld; and Haid & Neu, Karlsruhe, to make your picture of the German sewing machine industry even more complete. Singer Naehmaschinen A.G., Frankfürt, is not a factory, but a commercial firm only; in Germany, Singer machines are produced by Haid & Neu. We have not established a subsidiary in Spain, but granted a manufacturing licence in 1954 to a Spanish firm for a particular model of our zig-zag sewing machine.

As to our company's activity in the United Kingdom, it may be true that no invasion has occurred but there is no doubt that we have succeeded in securing quite a good foothold in the British market. Although we are continuously faced with new problems and difficulties (such as hire purchase terms), the results achieved prove satisfactory, bearing in mind, of course, that ours are high quality and high-priced machines, mostly of the new automatic zig-zag type, which, under certain aspects, may appear rather revolutionary to the conservative British housewife.

Regarding your concluding remarks, about the sale of sewing machines in different countries, our records regarding sales of sewing machines per 1,000 of population do not correspond to the figures quoted by you, especially as regards Italy, where we reckon with a total sale of roughly 255,000 machines a year, that is, 5 per 1,000 persons. We also think that 2 per 1,000 in the United Kingdom is rather low and that 3·5 per 1,000 would be nearer to reality.

Please let us state again that we have deeply appreciated your study on the sewing machine industry and on our company in particular.

Very truly yours,

ING. A. PAGNI.

Direzione Centrale,
Necchi Società per Azioni,
Pavia,
Italy.
September 17, 1957.

★ ★ ★

"PROPELLANT" AND THE O.E.D.

SIR, May I draw attention to one of the few but important differences between orthodox and Oxford spelling? In the *Oxford English Dictionary* the ending -ent is given without alternative, although -ant is unquestionably the established usage.

Authorised by Roget (who had completed his *Thesaurus* before the *O.E.D.* was first mooted in 1857), adopted by the Edinburgh dictionaries and used by the leading professional authorities, the ending -ant may be seen in print in all the text-books and in almost every relevant contributed article in the technical and national Press. The learned authors of the *O.E.D.* very properly attempted to lay down a rule of distinction for such endings. Their rule, based on end-forms occurring in the various conjugations of Latin verbs, may have had a mnemonic value when literacy was synonymous with a classical education. To-day, however, there is no market for Latin-based mnemonics, and there is very little need for any mnemonic at all, when everyone with a pen in his hand can have, and should have, a *Concise Oxford Dictionary* on his desk.

Sir James Murray and his collaborators proposed, or adopted, this rule, but they themselves had to break it as a concession to usage before they had got through half the letter B. Belligerent is admitted as "wrong correction of earlier -ant." If only "the late Mr. C. B. Winchester," who drafted the section PROFIT to PRY over 50 years ago, had counted a ballistician among his acquaintance, we should have had propellant in our Oxfords to-day. It may be argued that the problem of these alternative endings is as trivial as the dilemma of the big-enders and little-enders in Lilliput. But the continued perpetration of this solecism in our favourite dictionary tends to reach the dimensions of a public mischief, when the time of professional men is so frequently wasted in refutation of the importunity of members of that large and growing cult—the Concisers—whose *credo* is "My dictionary, right or wrong."

We owe much to the classical scholars—the word-doctors and the language-doctors—who would have us conform to the exemplary standards of Latin and Greek literature, but I for one refuse to be bound by orthographic and etymological pedantry in respect of words that Caesar never knew nor dreamed of, such as the fuze of a shell, the tyre of a motor-car, and, of course, propellant. Our debt to the classical scholars would be even greater if they would admit this plea for the recognition of established usage, and, at least, give alternatives of equal weight, and in alphabetical order.

I give below some authorities for propellant.

Yours faithfully,

E. H. BATEMAN.

Sandyridge,
Upper Bourne, Farnham,
Surrey.
October 1, 1957.

Text-Books
Internal Ballistics, H.M.S.O., 1951.
Interior Ballistics, by J. Corner, 1950.
Rockets and Guided Missiles, by J. Humphries, 1956.
Realities of Space Travel, by L. J. Carter, 1947.

Technical Journals
ENGINEERING: "Rocket Motor Oxidants," vol. 179, page 78 (1955).
The Engineer: "Rocket Problems," vol. 196, page 594 (1953).
Aircraft Engineering: "Guided Weapon Engineering," vol. XXIX, page 258 (1955).

Professional Journals
Proc.I.Mech.E.: James Clayton Lecture on "Guided Missiles," vol. 169, page 30 (1955).
J.R.Ae.S.: "Rocket Engines," vol. 61, page 81 (1957).

National Newspapers
The Times: Annual Review "Survey of British Aviation," September, 1955.
The Sunday Times: "Problems of the 15,000 m.p.h. Rocket," September 1, 1957.

★ ★ ★

DISTINGUISHABLE FIGURES

SIR, Referring to the valuable lettering designs suggested in "Data on Human Performance for Engineering Designers," on page 248, August 23, 1957, may I suggest that it would be well to make the 9 so that when inverted it could not be a 6.

The 6 could have the loop left open. The 9 could have its stem straight or even reverse-curved like a 7. The stem could even curve upwards a little, as in letter *a*.

Yours truly,

B. HODKINSON.

59 Barnfield,
Urmston,
Manchester.
October 4, 1957.

★ ★ ★

DISTINGUISHABLE IDEALS

SIR, One of the most heartening news items to appear recently is your statement (Marketing, page 338, September 13) that the Germans have abandoned their search for *Lebensraum* (living-space) and are now concentrating on *Liebestraum* (dreams of love).

Very truly yours,

R. E. HANSEN,
Development Engineering Department.

Elliott Company,
Jeannette, Pa., U.S.A.
October 1, 1957

Companies in the News

Capital for Africa

In the latest issue of the *Statistical and Economic Review* put out by the United Africa Company, Limited, there is an interesting article on the finance of development in tropical Africa. Much of the capital is supplied from private sources, and in the post-war period covering the 11 years 1945 to 1956 the United Africa Company, Limited, itself invested £23 million in gross capital outlay in Ghana and the three British dependencies of Nigeria, Sierra Leone and Gambia.

On the public side there are four United Nations financial agencies at work. These are the International Bank for Reconstruction and Development, the International Finance Corporation, the International Monetary Fund (which accepts drawings to supplement foreign exchange reserves in general and does not take part in individual development projects), the United Nations Technical Assistance Programme and the Special United Nations Fund for Economic Development. In addition to these there are a number of organisations at work sponsored by the United States and Western European countries. The International Co-operation Administration, which is descended from the Economic Co-operation Administration, administers the famous " Point Four " programmes and there is also the Export-Import Bank. There is also the projected European Investment Bank and Fund which will be set up under the Treaty of Rome from January 1, 1958, to finance investment in the territories of the European Economic Community and which will in effect probably benefit mainly French and Belgian territories.

In the case of the United Kingdom there is the Colonial Development and Welfare Fund in operation, the Colonial Development Corporation and the Commonwealth Development Finance Company. The French have two organisations at work channelling funds into Africa. There is the Fond d'Investissements pour le Développement Economique et Social and the Caisse Centrale de la France d'Outre-Mer. The second of these, the Central Financial Organisation, is responsible for managing the accounts of F.I.D.E.S. The French Development Fund was provided from an initial grant under the French Budget. In the case of Belgium, development funds do not come from the Belgian taxpayer. In the Belgian Congo, for instance, money is provided by loans floated in Belgium and the Congo, the Belgian Government on occasion acting as a guarantor.

★ ★ ★

Outlook in Steel

The heads of steel manufacturing companies reporting to their shareholders in the past month were unanimous in their expression of confidence in the future. Order books were full and the trend of demand encouragingly upwards. The motor industry had recovered and—in special steels particularly—the industry still had a long way to go to meet all the demands upon its capacity. But only one of these chairmen had written his speech since the Government announced their new wave of anti-inflationary measures. Had they all done so it is almost certain that they would have been less optimistic, for their prosperity depends to a large extent on car production and building activity.

Three of the companies whose annual statements were published recently—Walter Somers Limited, the Union Steel and Manufacturing Company, and Wellington Tube Works Limited —are important suppliers to the motor industry. Mr. Frank Somers, chairman of Walter Somers, considered that " providing there is no shortage of steel and given settled conditions " his company could " look forward to the future with confidence." The expansion of the company's range of forgings up to 2 tons, and their entry into the market for handling equipment will considerably broaden their trading basis. Mr. Ronald Hampton, chairman of Union Steel—who supply most of their products to the motor industry—said that they viewed the future with confidence and not without optimism. Yet Mr. Hampton spent much of his time talking about rising costs and pointing out the dangers of wage demands. Mr. D. W. Turner, chairman of Wellington Tube, expressed what must now be a general feeling in the steel industry: " Since the end of the financial year there have been some signs of improvement in demand, but in view of the further Government restrictions recently imposed I must regard the immediate future with some caution." Much of their output of tubes is for the building industry and of their output of stampings for the motor industry. But it is the " immediate future " which is in the balance. For steel, as for most of engineering, the years ahead can hardly be other than years of expansion.

★ ★ ★

Steel Plant

The outlook of the makers of steel plant reflects primarily the steel industry's own calculations concerning its long-term future. For two of the leading companies in this field, increasing steel consumption means fully booked capacity for several years and continued expansion. Announcing that his company had decided to embark on a second stage of expansion immediately on completion of the first, Mr. D. F. Campbell, the chairman of Davy and United Engineering Company, referred to the British steel industry's expansion plans. They involve the expenditure of £800 million in the next five years and cannot be greatly cut back without prejudicing the whole future of British engineering, particularly its export potential. The first stage of the company's expansion was for an increase of output of about 20 per cent.; the second stage is for a further increase of 30 per cent. It is based on the expectation of " a continuing demand at the current level after the next five years " and will go ahead provided the necessary finance can be obtained. The considerable additional investment involved, Mr. Campbell points out, " presupposes that the steel industry will continue to buy its machinery at home and will not resort to large-scale imports." Here is a warning, perhaps the most pointed so far, that our heavy industry could not, or would not undertake large-scale investment (or be able to attract the investors) if it were to be exposed to the full blast of Continental competition within a Free Trade Area.

Another steel-plant manufacturer, the Wellman Smith Owen Engineering Corporation, have embarked on major expansions to meet increasing demand. Their chairman, Sir Peter G. Roberts, points out that on the basis of existing contracts work is around " for a number of years to come." The company are working on the development of the oxygen-enrichment process and have made great strides to establish themselves as technical leaders in world markets. Two other companies, EFCO Limited and Incandescent Heat Company, Limited, report considerable achievements both technical and commercial. The prospects for the suppliers of steel plant appear more solid even than those of the steel makers themselves; they are less subject to short-term fluctuations.

★ ★ ★

Shipping Prospects

A great deal of gloom has been generated, in recent weeks, by commentators on Britain's shipping position, and most of it has been inspired by the shipping industry's own jittery attitude to a slump in freight rates. Talk of cancelling orders for ships and laying-off large numbers of modern craft has unsettled the industry and frightened away from the shipbuilding centres the capital so urgently needed for expansion and modernisation. Some of the possible results from such an attitude can be inferred from the note on United States shipbuilding on this page. It is apposite to recall two recent statements: one by Mr. Onassis only some six months ago, to the effect that the world's capacity for tankers was barely adequate to meet replacement demand; and one by Mr. Daniel K. Ludwig—who recently placed an order in Japan for five tankers worth £45 million—to the effect that the oil companies' forecasts of a tanker surplus are off the mark and irrevelant in so far as modern tonnage is concerned. Ludwig, like his Greek competitors, Niarchos and Onassis, is clearly staking his chances on the superiority of super-tankers.

One of the largest and most progressive of British shipping companies, Furness Withy, reported to their shareholders last month " improving results despite difficulties " and a " continuing process of fleet replacement." Their chairman, Sir Ernest H. Murrant, described the position of the group as " thoroughly sound." To maintain a well-diversified fleet and to keep abreast " of ever changing conditions " the group have committed themselves to an expenditure of £13·8 million in the next three to four years. The same point was made by Captain A. R. S. Nutting, chairman of Coast Lines. It is likely to be made by every operator who has the capacity to look ahead and the ability to win the means (mainly financial) of keeping abreast of developments.

British shipping is entering a new period of revolutionary change, with higher speeds, larger ships and possibly new methods of propulsion around the corner. There are few doubts as to where the cost advantages lay: there will be a great deal of redundancy in the world's fleets, but it will be healthy redundancy—due to obsolescence rather than lack of work.

★ ★ ★

Orenda's Export Successes

Orenda Engines Limited, one of the young Canadian offshoots of the Hawker Siddeley Group, is establishing a firm footing in the world aero-engine market. They have received an 8 million dollar order from the West German air force for spare Orenda 14 turbojets and parts —in support of Germany's order for 225 Canadair-built Sabre 6 fighter aircraft which are fitted with Orenda engines; and their new over 20,000 lb. thrust supersonic turbojet, the Iroquois, is to be built in the United States under licence by the Curtiss-Wright Corporation. The agreement with Curtiss-Wright is to run for seven years and covers the exchange of technical information between the two companies as well as the rights for the manufacture, sale and further development of the Iroquois in the U.S.

The Iroquois, it may be recalled, was developed initially as a private venture, specifically to power the Arrow supersonic airliner which Avro Aircraft Limited are developing for the Royal Canadian Air Force. The Arrow was scheduled to make its first public appearance (on the ground) at an official unveiling ceremony in Malton, Ontario, on October 4.

★ ★ ★

Rough Road for Wagons

Recent statements by the chairmen of Gloucester Railway Carriage and Hurst Nelson suggest that the shortage of steel which held back output last year is now much less acute. General Sir William Morgan, chairman of Gloucester Carriage, said that although supplies were still inadequate something closer to full capacity output should be possible this year. Orders were sufficient to ensure full production throughout the year.

The remarks of Mr. A. N. Forman, chairman

of Hurst Nelson, were equally comforting for the short term—" our order book assures employment of our men and machines for more than a year ahead," he said—but distinctly disturbing beyond this. Mr. Forman's company anticipate a recession in the home demand for their normal products and have therefore been developing their manufacturing facilities " with a view to participating in a wider range of alternative work." The company's relatively poor results last year—trading profits declined from £204,000 to £142,000—were due mainly to their being starved of steel and thus having to produce at an uneconomic rate.

Two other companies, Westinghouse Brake and Signal, and Wagon Repairs, have been in the news recently. Westinghouse Brake's public issue last April, which raised just over £3 million, has made a major contribution to the financing of plant expansion and of stocks and work in progress though much of it was used to repay bank overdrafts incurred for this purpose. The company have benefited considerably from British Railways' £1,200 million modernisation programme; their production of the " Vespa " scooter through a subsidiary, Douglas (Kingswood), suggests that they—along with many others in heavy engineering—are attracted by durable consumer goods to offset the heavy plant cycles and the ups and downs of capital investment. Wagon Repairs are doing very well: over 650,000 railway wagons and tank cars were repaired during the year and all their workshops were fully employed. But they also have expanded outside the industry: the manufacture of their " Handy Angle " slotted angle iron shelving and accessories has been transferred to a new company of that name.

★ ★ ★

75 Years of Ferranti

It is becoming increasingly rare for a company of world-wide repute to be able to trace its ancestry back through three generations of one family to its foundation by the head of that family. This year marks the seventy-fifth anniversary of the foundation by S. Z. de Ferranti and associates of the company known originally as Ferranti Thompson and Ince and eventually after various transformations to become in 1898 the company now known as Ferranti Limited. Virtually under the direction of one family, the original business, of which generators and electricity meters were the principal products, has expanded to the present organisation with world-wide interests and its products range from semi-conductors through the field of electronics, guided weapon control systems, computers and machine-tool control systems, instruments and domestic appliances to the power transformers which became such a prominent part of the business in the 1920's under the direction of the present chairman, Sir Vincent de Ferranti.

It is perhaps true to say that the name Ferranti has in general been better known in the past among engineers than among the general public, though the latter knew of Ferranti radios and continues to use the company's domestic appliances. Recent technical developments have, however, received more than their fair share of journalistic treatment and in connection with firstly computers, and then computer-controlled machine tools and guided weapons, the company is and is recognised to be one of the leaders in this country. The first practicable electronic digital computer to be built in this country by an industrial concern was that built for Manchester University by Ferranti; it began operating in 1951. Ferranti now have the largest team working on computers (some 700) outside the United States.

The guided weapon programme in this country has produced several disappointments, but here again Ferranti, in conjunction with Bristol, have been successful in developing the complete defence system, Bloodhound, which will form the basis of air defence of the United Kingdom in the next generation.

SATELLITES AND TECHNICAL LEADERSHIP

AN INTERVIEW WITH P. I. KAPITSA

During his recent visit to the Soviet Union, Mr. E. P. Ward, a Deputy Editor of ENGINEERING, *interviewed Academician P. I. Kapitsa. A report of the interview, together with his own comments, is published below. The fifth in his series of articles " How Good are Soviet Engineers? " appears on page* 460.

The Russians have launched a satellite. They have tested a transcontinental missile. They have built a successful jet airliner. Already there are signs of uneasiness in the West. Are the Russians scientific prodigies ? Is their society destined to technical pre-eminence ? In a few years, it is whispered, we shall have fallen far behind; the vast numbers of trained engineers at the Soviet Union's disposal will give them an irretrievable advantage. But is the situation really so alarming ? While in Russia, I had the opportunity of speaking with Academician P. I. Kapitsa, a leading Soviet physicist and former Cambridge research student. He is also reported to have played a prominent part in the earth-satellite project. With his assistance I was able to see Soviet technical achievements in perspective.

P. I. Kapitsa was in residence at Trinity College, Cambridge, more than 30 years ago. Though trained as an engineer, he worked on natural science with Lord Rutherford in the Cavendish Laboratory, and was a close friend of J. D. Cockcroft. He was responsible for giving Rutherford the nickname " Crocodile," a circumstance that is to-day recorded in bas-relief on the walls of a Cavendish building. A few years before the last war he returned to the Soviet Union, and since then little news of him has reached us.

As soon as I entered Kapitsa's large neat office at the Institute of Physics Problems (named after S. I. Vavilov), in Moscow, he recognised my Trinity tie, and said that he remembered Cambridge well. On his shelves, I noticed the broad red back of *Who's Who* and other English books of reference. His flushed complexion and lively eyes gave him a spirited appearance, though his hair was grey. He wore a modern cream linen jacket and in contrast a Russian embroidered shirt. He was extremely courteous and spoke English clearly and well.

He was working on problems of low-temperature physics, as he had at Cambridge, and explained to me that this branch of study was useful in the development of relays and " memories " for computers, and also in the separation of heavy hydrogen from natural hydrogen, and oxygen from air. It is significant that liquid oxygen has been used as one of the propellants in long-range rockets. I inquired whether his work was also concerned with nuclear spins and other phenomena studied by means of super-cooling techniques, but he assured me that his institute never troubled with temperatures below 10 deg. K. It was apparent that the Vavilov Institute had its nose to the grindstone of very practical problems, as is the case with most other institutes of the Academy of Sciences. Academic or " pure " research in the Soviet Union clearly keeps its eye on less academic applications.

But increasingly the Soviet authorities are recognising the importance of technical and scientific independence. Writing in *Pravda* recently, Kapitsa declared: " The more independence and initiative a man has on his job, the greater his productivity of labour in comparison with that of a worker whose cultural level allows him to do a good job only when he executes detailed directives handed down from above." I asked him if he had learned this attitude to scientific work in Cambridge. He answered: " By no means, it is merely common sense."

It struck me that it was a form of common sense only recently applied in the Soviet Union; and even now writers and artists are not offered the same freedom. While I was in Moscow I read an article in *Pravda* in which Mr. Krushchev insisted that books and pictures should serve the Soviet people, not simply by enlarging their ideas but by helping to expand production.

This singleness of purpose was treated rather more subtly by Academician Kapitsa, who told me that, in fact, scientific freedom was also relative. " Knowledge," he said, " is to-day so vast that one is forced to choose a limited field of work; since certain fields are likely to be more productive than others, these are generally the ones in which work is most active. Thus two branches of mathematics are theory of numbers and calculus; until recently little use has been found for theory of numbers and it is consequently neglected, while calculus flourishes."

Scientists, he continued, often defended their independence in the face of interference or planning by asserting that knowledge was their aim and curiosity their motive. But this was a futile attitude. Science, he said, must be the servant of technology. In his view planning was not incompatible with initiative, and would become decreasingly so. In engineering planning was almost second nature.

Planning, he believed, gave the Soviet Union an immense advantage. It was also a vast country with an abundance of raw materials. In this respect a country as small as Britain was at a disadvantage; it was well known, he said, that British engineers were the best in the world, but with limited resources they would be hard pressed to compete. The Soviet Union, on the other hand, could fling massive resources into selected projects, with almost inevitable success. In this way the Russians have produced not only the Tu 104 and 110, the ballistic missile and high-performance turbines, but also unprecedented numbers of apartment houses. Now in addition they have made the earth's first satellite—not counting the moon. It should be borne in mind, of course, that the earth satellite and the ballistic missile are broadly the same project, both requiring similar data.

Engineering projects of this kind are necessarily based on associated research programmes, and in *Pravda* Kapitsa described a form of research " commando " fitted to this purpose. " Such an organisation for the solution of scientific and engineering problems may be visualised as a mobile combat force drawn from units of the various services." Thus for developing an earth satellite, the commando would comprise physicists, mathematicians, aerodynamicists, astronomers, electronics experts, metallurgists and other specialists, taken from thematic research institutes or universities, to which they would return once the project was complete. As an *ad hoc* procedure this practice is already familiar—the Atomic Energy Research Establishment at Harwell is an example—but in stating it explicitly Kapitsa illustrated the systematic approach to organisation which characterises Soviet technology.

Soviet engineers are equally systematic in their study of Western methods. I saw tables of data on British, American, West German and other foreign machine tools at one research institute, and there is a familiar look in many Soviet products. When I asked Kapitsa if Soviet designers ever resorted to imitation, he agreed that for a backward country, as Russia

certainly had been, it was often more expedient to copy foreign products than to plod through routine elementary work.

Towards the end of our conversation, Kapitsa remarked that the Russians were not quite as single-minded as I might suppose and that they had been especially successful in the somewhat remote fields of archaeology and palaeontology. In fact Kapitsa's institute was decorated with photographs not of low-temperature distillation apparatus but of Greek ruins. He said that Russians did not direct all their attention to practical ends—after all, they were great chess players.

This less earnest attitude and the news that Mr. Krushchev favoured decentralisation prompted me to inquire whether Academician Kapitsa considered that West and East were gradually moving towards each other. This appeared to him a superficial view; there were fundamental differences and the real position was much more complex. Presumably he believed that his own country held the highest cards. But what he had said and what I had seen led me to less definite conclusions.

To apply vast resources to single projects is a wasteful procedure, particularly in a highly technical society where all aspects of engineering are closely interlocked. Thus, the high-temperature materials developed for gas turbines may be useful to the nuclear engineer; if theory of numbers is neglected then the mathematical tools for digital computers may not be available when they are required.

What is more, it is only where the problem is already formulated and well defined that it can be tackled in this way. Indeed, the entire Soviet system, with its emphasis on planning, is geared to problem solving rather than creative growth. Thus when a significant new discovery is made, or new materials are discovered, it may mean a complete re-orientation of a five-year plan, as has recently occurred. For the same reason, development can only proceed along prescribed paths—faster cutting speeds, higher temperatures and pressures, greater economy. I asked at a machine-tool research institute what would happen if there were no West to set the pace? I was told that it was a matter of constantly raising the standard, an answer which seemed to me unsatisfactory. Technical advance depends eventually on the formulation of new problems.

In the field of satellites and ballistic missiles the West has been overtaken; and apparently no longer sets the pace. But though a greyhound may overtake the hare which it pursues, it must eventually fall back or lose the way.

Not to applaud the Soviet achievement would be churlish. The launching of the first artificial satellite is an undoubted triumph, which has taken the world by storm. But one satellite does not make supremacy. There is certainly no mysterious driving force in the Soviet economy pointing to inevitable leadership. Unlike Academician Kapitsa, I am not even certain that differences between West and East are fundamental, for though the theory quoted might be different, the practice is often much the same. Each way of life has its advantages: thus systematic exchange of information prevents duplicated effort, while trade secrecy is a stimulus to discovery; controlled planning may give direction to activity, but the direction may be wrong. The Soviet Union has made good use of its particular advantages, but to understand them is to divest them of their magic. Soviet engineers have problems similar to our own. They are not marvels; they are men.

THE SATELLITE: CONSIDERATIONS OF SCALE

The fact that the successful launching of the first artificial earth satellite on October 4 was accomplished by the Russians was not entirely unexpected by Western astronautical scientists and engineers; but it does seem to have come as a surprise that the satellite itself should be so massive. The American Vanguard satellite, as originally designed, is a 20 in. sphere weighing some 10 kg; the Russian satellite, said to be a 23 in. sphere, weighs some 84 kg. Vanguard is to be launched by a three-stage rocket with an initial mass of about 10 tons; its launching site and path have been chosen so as to take advantage of the earth's rotation which will contribute 1,170 ft. per sec. to the vehicle's velocity. The Russian satellite, which was launched on a Polar orbit, has not got the advantage of this rotational contribution—the launching rocket has supplied practically the whole of the 26,000 ft. per sec. orbital velocity, and it has taken it to a higher altitude—560 miles was claimed and appears to be confirmed by observations; whereas Vanguard is to be launched to a nominal altitude of 300 miles. It seems probable, then, that the launching vehicle would have had to provide at least 10 to 12 times the energy of the Vanguard vehicle.

In fact, the designing of such a launching vehicle, perhaps of the order of 100 tons and probably comprising three rocket stages, might well, on the evidence of American rocket engineers themselves, have proved a more straightforward task than that of designing the Vanguard vehicle. To say this is not to belittle the Russian achievement, which is bolder than the American approach; and in control techniques they have surpassed Western capabilities.

As the scale of the rocket is increased, the installation difficulties become somewhat less formidable; and the structural efficiency of the small vehicle is well below the optimum. According to Convair-Astronautics, the optimum efficiency should be attained at launching weights of some 50 to 100 tons, and conventional liquid-fuel rockets would be adequate for the task. It seems to be generally thought that the first-stage rocket of the Russian launching vehicle is, in fact, identical with that of the intercontinental ballistic missile that they claim to have fired recently—a claim which now seems justified. According to *The Daily Telegraph*, quoting Professor Pobedonotsev, the first-stage rocket of the satellite launcher accelerated the vehicle, which took off vertically, to a speed of about 4,300 to 4,700 m.p.h.; at a height of a little more than a mile, the trajectory began to incline and by the time the first-stage rocket fell away, the vehicle was moving at 45 deg. to the earth's surface. A second-stage rocket boosted the speed to about 12,250 to 12,500 m.p.h. After the second rocket fell away, the rocket coasted until it was moving parallel to the earth's surface, about 625 miles from the launching site, and at this point the third-stage rocket fired, boosting the speed to about 18,000 m.p.h. and releasing the satellite, which was housed in the nose.

Metals and Materials

PLASTICS BONDED TO STEEL

An important new material for the engineering industries—steel sheet bonded to a polyvinyl chloride plastics—was introduced in this country last week by John Summers and Sons, Limited. Known as Stelvetite, the material was developed by John Summers and B.X. Plastics Limited and is produced at Shotton. The plant is to be increased in size until by the end of the year the capacity is expected to be several hundred tons per week. The start of production on a commercial scale represents a considerable achievement for the British steel industry. In addition to the plant operated by John Summers a similar plant for the production of plastics coated strip is also being operated by the British Iron and Steel Research Association, and two other companies are said to be in the development stage. In the United States there are two producers, the United States Rubber Corporation and the United States Steel Corporation, but the product introduced by John Summers has a thicker coating (up to 0·014 in.) than the American products. In the process operated by the United States Steel Corporation, the plastics is in the form of a film painted on to the steel, whereas Stelvetite is the result of bonding P.V.C. sheet to the steel.

It is claimed that Stelvetite can be worked and treated as ordinary steel sheet without damaging the plastics surface. It can, for example, be bent, formed, seamed, deep drawn, joined and welded without damaging the coating. The material is also claimed to have good electrical insulating properties and to be highly resistant to acids, alkali, greases, detergents, the weather, humidity and abrasion. Colour can be incorporated in the P.V.C. and therefore the need for surface finishing treatments is eliminated. The manufacturers claim that from the cost angle Stelvetite is a very economical proposition and is cheaper than stainless steel. It is, of course, more expensive than uncoated cold reduced steel, but the manufacturers state that for many uses this higher cost is offset by the elimination of normal finishing costs. The total cost of applying the coating is said to be about the same as that of applying a high-quality enamel finish.

The material is available in steel gauges from 26 g. (0·0196 in.) to 16 g. (0·0625 in.) and in sheet lengths and widths up to 144 in. and 48 in., respectively. The reverse side of the sheet can be either a Bonderised steel or electro-zinc-coated surface. A number of applications are expected in the furniture and motor vehicle industries and also in the production of many domestic appliances. It would seem possible that in the early stages the sales may be restricted by the relatively high price since where enamelling, cellulosing or painting plants are already in existence, users of steel sheet may prefer for the time being to continue to make use of them. There can be little doubt, however, that in the longer term users of steel sheet will welcome the elimination of these processes. It has been estimated, for example, that the cost of sheet steel for a motor-car body represents one-third of the total cost of the body and requires about three coats of paint. It is claimed that the cost of a body finished in Stelvetite is less than that of one with a traditional surface coating. Moreover, the plastics coating where Stelvetite is used would be about five times as thick as a normal paint coating. In general, because of the thickness of the P.V.C. coating, surface blemishes on the original sheet steel are of much less importance than when the steel is to be painted.

The plastics coating employed is a special Velbex P.V.C. coating developed by B.X. Plastics Limited. It is understood that attempts have been made to use other types of plastics, but that polyvinyl chloride has hitherto proved the most successful for two main reasons: it is easier to obtain a strong bond between P.V.C. and steel than when using any other plastics and the coating will not shrink under any conditions to which the material is likely to be exposed.

Since the advent of plastics on a commercial scale the question has been asked how soon it will be possible to develop a plastics which will be of sufficient strength to replace steel in applications where the latter must be painted or otherwise protected from corrosion. As is often the case where a new material is first seen as a threat to the market for established materials, a useful field of co-operation has been developed. Though improvement in the strength of plastics will continue, such as through the development of polyester-resin glass-fibre compositions, there are likely to be many fields for the application of plastics coated steel sheet for several years to come.

Metals and Materials

TUBE INVESTMENTS AND ALUMINIUM

It was announced last week that, subject to Treasury approval and to completion of formalities, Tube Investments Limited had concluded an agreement with United States Reynolds Metals Group to combine the interests and activities of the two organisations in the aluminium industry in the United Kingdom. A joint subsidiary company, Reynolds Metals and T.I. Aluminium Limited, is to be set up to take over the existing aluminium interests of T.I. Aluminium Limited and will be owned on a fifty-fifty basis by Tube Investments and Reynolds.

Tube Investments have undertaken a great deal of capital expenditure on aluminium fabricating plant in the post-war years and in the chairman's review, issued with the accounts in November, 1956, it was stated that the return on this capital for the first time in 1955-56 touched reasonable proportions following the losses incurred two or three years previously. In addition to producing aluminium extrusions and tube, T.I. Aluminium own the large continuous aluminium sheet mill at Neath, which is operated by the South Wales Aluminium Company. In 1956 shortage of virgin aluminium prevented this plant from reaching its rated capacity but towards the end of the year, with orders falling off, metal supplies became easier and keen competition developed.

Reynolds Metals Company is, of course, a fully integrated producer of virgin metal and of fabricated aluminium products, having a production capacity of 600,000 tons per annum of virgin metal. In the present state of overproduction of aluminium the company stands to benefit from an enlargement of its interests in the output of fabricated products. Reynolds are also the world's largest producers of aluminium foil and the merger may therefore presage increased interest in foil production in this country. In particular Reynolds have been developing the use of foil containers for foodstuffs, including meat, on sale in supermarkets. They are also carrying out research into the wrapping of bread in aluminium foil, which is claimed to prolong the edible life.

T.I. and Reynolds are to pool their combined resources—technical research, commercial and metal supplies in the new company, which may be expected to make an important contribution towards expanding the range of applications of aluminium in this country and thus help to reduce the present world over-supply.

BURIED COPPER TUBES

First published in August, 1947, British Standard 1386, which covers copper tubes to be buried underground, has now been issued in revised form. The revision provides for tubes for the same applications as those covered by the original edition, namely, tubes suitable for connection by means of compression or capillary fittings, or by bronze or autogenous welding, and to be buried underground, for the conveyance of water, town gas and other supplies.

It may be recalled that, in type A compression fittings, the joint is made by the compression of a loose ring or sleeve, or part of the fitting, on to the outside wall of the tube. In type B compression fittings, the joint is made by the compression of a manipulated portion of the tube, at or near its end, against the face of the body of the fitting or against a loose ring or sleeve within the fitting. In capillary fittings the joint is made by the flow of solder by capillarity along the annular space between the outside of the tube and the inside of the socket of the fitting.

As in the previous edition, tubes are standardised on the basis of outside diameter, the outside diameter selected for each size being that laid down in B.S. 659 : 1955, one wall thickness being recognised as standard for each nominal size.

The value of the maximum tensile strength for annealed tubes and the minimum tensile strength for as-drawn tubes has now been reduced from 17 tons to 16·5 tons per sq. in., and the included angle of the tapered drift used in the drifting test has been amended to 45 deg. This is the angle now being adopted in all British Standards for copper and copper-alloy tubes.

Other amendments are a modification of the "freedom from defects" clause to ensure that deleterious films are not present in the bore of a tube, and a new clause which stipulates the marking of tubes with bands of adhesive tape indicating the number of the standard and the temper of the tubes supplied. This last measure is in addition to the permanent marking of the tube with the supplier's identification mark.

Copies of the new revised Standard may be obtained from the British Standards Institution, Sales Branch, 2 Park-street, London, W.1, price 3*s*. post free.

ALUMINIUM TREAD PLATES

The positive-grip pattern (P-G-P) aluminium tread plate manufactured by the British Aluminium Company, Limited, Norfolk House, St. James's-square, London, S.W.1, is attractive in appearance; the metal is, of course, non-rusting, hygienic and easy to clean, and it is therefore suitable for use on floors, walk ways, lorry platforms, ramps and elsewhere in the brewing, dairy and similar industries and in food-processing plants, while its light weight is of benefit in transport applications.

The tread plate has so far been available only in two patterns: heavy and light. Now, however, it can be supplied in small pattern, which is a completely new design complementary to the other patterns. In the heavy pattern the prominent "lozenges" which are approximately 0·090 in. high, ensure a long life. The material is available in BA25 alloy which is of the wrought Duralumin type in the W and WP conditions, (i.e., in the solution-treated, and the solution-treated and precipitation-treated states), and in base thicknesses of from $\frac{3}{4}$ in. to $\frac{1}{8}$ in.

In the light pattern the lozenges are approximately 0·035 in. high and the material is available in aluminium of commercial purity (99 per cent.) and in BA25 W and WP alloy. The base thicknesses range from $\frac{1}{4}$ in. to 0·064 in.

The small design of the new "small pattern" plate has been devised for such components as kickplates, bulkheads and flooring on passenger transport. Like the light pattern plate it is available in commercial-purity aluminium and in the BA25 W and WP alloy. The upper base thickness limit is normally $\frac{1}{4}$ in. but greater thicknesses may be available on request. The lozenge height in the new small pattern plate is approximately 0·046 in.

INSTRUCTION IN STEEL METALLOGRAPHY

Forming part of a series of instructional cinema films on iron and steel, produced for the British Iron and Steel Federation by Merton Park Studios Limited, three new films on the structure and properties of steel were shown recently in London. The three films are of the black and white, sound, type and are available in both the 16 mm. and the 35 mm. prints. They are intended for showing in works and classrooms.

The first film, entitled "Grain Structure," runs for 16 minutes, and explains how the grain structure and grain size of steel are affected by its carbon content, the manner in which it is worked and the heat treatment given.

The second film, entitled "Carbon Content," runs for 12 minutes and explains how the distribution of cementite and ferrite in the metal governs its grain structure and therefore its properties. The third film runs for 17 minutes and is concerned with heat treatments.

The three new films and the nine already produced are obtainable on free loan on application to the film library of the Federation, Steel House, Tothill-street, London, S.W.1.

COSTING FOR NON-FERROUS METALS

The British Non-Ferrous Metals Federation has issued a brochure called "Cost Finding in the Non-Ferrous Metals Industry" for the use of its members.

In a foreword, the chairman of the costing committee explains the reasons which prompted the Federation to undertake the exercise. Members of the non-ferrous metals industry were mostly members of trade associations federated to the British Non-Ferrous Metals Federation and took part in the high degree of collaboration which existed in the days before price regulation came to an end in 1956. The existence of an agreed price structure had meant that some companies could rely on costing their main products themselves but obtaining cost information from other members of the associations for their other lines. The abandonment of price regulation thus cut off some members of the industry from existing sources of information. This brochure is the outcome of this situation.

The Federation commends the committee's work to the industry in the interests of managerial efficiency as well as good costing practice. It does not lay down a complete and detailed costing system and is not a substitute for one. It sets down broad principles with examples to illustrate the points. The Federation's cost accountant is to visit member firms and advise on the way in which the basic principles can be applied to individual products and circumstances. It is to be hoped that the need for a broad outline of good costing practice for the industry will be made the basis for the exchange of information, under the Federation's auspices, which can be used for individual companies to measure their efficiency against the industry as a whole. There is here the basis for an organised attack on the export market, if the information is properly collected and analysed, as well as accurate cost data for pricing and budgetary purposes.

* * *

COVERED ELECTRODES

Welding Mild Steel

A new type of manual welding electrode which, it is claimed, combines the good welding properties of the British Standard 1719 (class 2) electrodes with the good mechanical properties and "X-ray-sound" weld metal of the low-hydrogen class 6 electrodes, has been introduced by Quasi-Arc Limited, Bilston, Staffordshire, for the welding of mild steel.

This electrode, Ferromax, has a rutile type of covering, into which iron powder has also been introduced. The electrode is stated to give a better shape of fillet weld than is obtained with standard low-hydrogen electrodes and to give off less fumes. The electrodes have been given the code number E.917 under the B.S. 1719 classification and conform to B.S. 639.

Plant and Equipment

R.M.S. QUEEN MARY'S FUEL SYSTEM

NEW HIGH-PRESSURE UNITS INSTALLED

In order to accommodate the new stabiliser equipment in the boiler rooms of the "Queen Mary," it was found necessary to re-arrange much of the ship's auxiliary machinery and to design oil-pumping and heating units of the required output which would occupy approximately one-third of the floor area previously taken up by the original units.

At the same time, the Cunard Company, wishing to take advantage of the latest developments in oil burning, decided to raise the working pressure of the oil system to 450 lb. per sq. in. and to install boiler room control panels to centralise all the combustion controls and necessary gauges in order to facilitate boiler control.

The task of designing, manufacturing and installing the complete new oil-fuel system called for the closest co-operation between the engineering departments of the Cunard Company and John I. Thornycroft and Company, Limited, Smith-square, London, the makers of the equipment, and was accomplished from start to finish in approximately ten months, in readiness for the ship to make her scheduled Atlantic crossing after the usual lay-up period for annual overhaul last winter.

As regards the stabiliser equipment, which is similar to the installation, also by Thornycrofts, on the "Queen Elizabeth," it is expected that its installation will be completed during the liner's forthcoming winter overhaul.

CONTROL PANEL

The boiler control panels were designed to centralise all the boiler combustion controls. One is illustrated in Fig. 1 and the arrangement of one of the pumping and heating sets is shown diagrammatically in Fig. 2. The panel incorporates all the fan controls, oil-fuel pump controls, the master oil-fuel pressure control valve and the necessary pressure gauges, thermometers and ammeters associated with the combustion equipment.

It is provided with dust covers, which should be lowered whenever it is not in use, especially when boiler cleaning operations are in progress.

The new oil-fuel equipment consists of four identical sets, one set being installed in each of the four main boiler rooms. Each set is basically composed of three pumps, three heaters and three sets of suction and discharge strainers. The output is designed so that the full evaporation from the six Yarrow boilers per boiler room is obtained by using two pumps and two heaters only, the other pump and heater giving 50 per cent. standby. Pumps, heaters and discharge strainers are connected so as to be fully interchangeable. With the oils at present in use, the settling tank must be maintained between 100 and 110 deg. F. in order to give a viscosity at pump entry between 2,000 and 1,000 seconds, Redwood No. 1.

The three Zwicky cast iron Duplex suction strainers each have an integral changeover cock and mild steel baskets fitted with 30 by 30 mesh straining medium. The position of the handle indicates which basket is in use. The suction strainers are independently connected to each of three oil-fuel pressure pumps through a cast iron sluice-type suction valve. Each of the three vertical Mirrlees Imo pressure pumps is of the screw displacement type with a body of cast steel, and is directly driven through a flexible coupling by a 15 h.p. variable-speed Laurence Scott electric motor. The output of each pump at the maximum speed of 1,200 r.p.m. is 14,500 lb. of oil per hour. Each pump is fitted with an adjustable spring-loaded relief valve designed to lift at a maximum of 450 lb. per sq. in. gauge and having the discharge returned to the pump suction.

A cast steel S.D.N.R. valve is fitted to each pump delivery branch and the three pumps then discharge into a common main. A branch from the common main leads to a Thornycroft fabricated steel spring-loaded master pressure control valve, situated in the centre of the control panel. Pressure control to the burners is obtained by returning part of the oil flow to the suction main, and the valve is capable of by-passing 14,500 lb. of oil per hour. In the event of failure of this valve it can be shut off, and emergency control is then exercised by the pump relief valves.

Also connected to the common discharge main is a three-way cast steel heater inlet valve box, each valve outlet branch being connected by a steel pipe to a heater. A boss welded to each of the heater inlet pipes has fitted a heater relief valve designed to lift at 500 lb. per sq. in. gauge and with an open escape to a tundish.

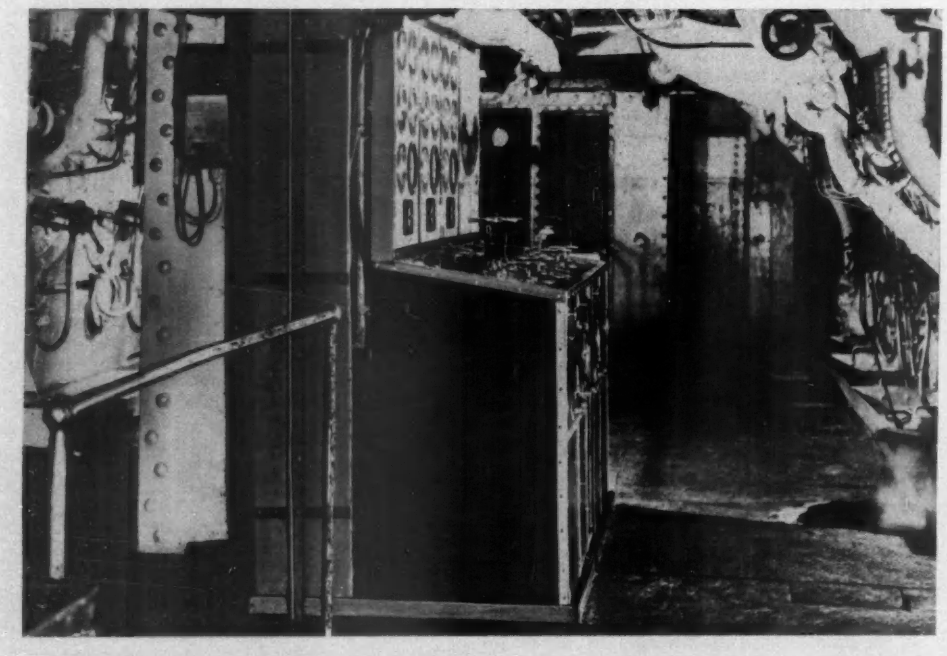


Fig. 1 The high-pressure oil-fuel system recently installed in the R.M.S. "Queen Mary" occupies only one-third of the floor space of the earlier one.

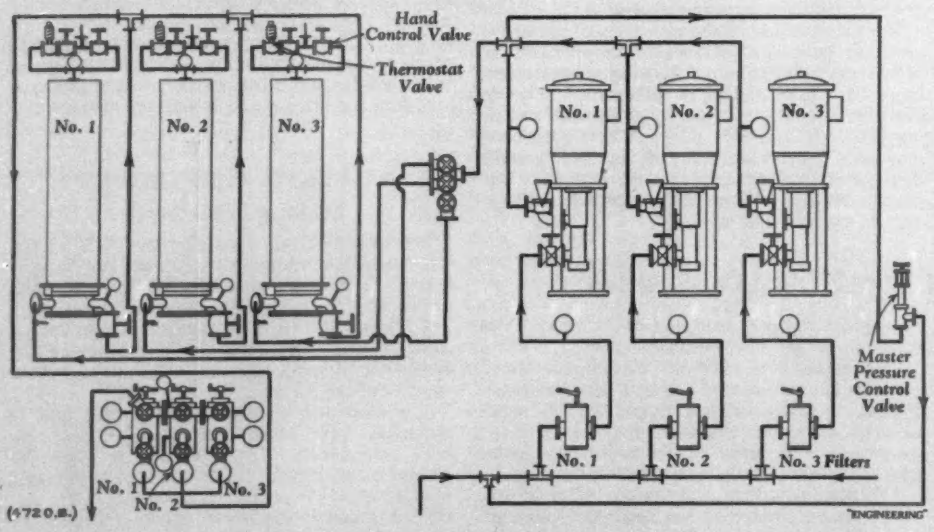


Fig. 2 There are three sets of pumps and heaters in each of the four boiler rooms. One pump and heating set feeds two boilers.

THERMOSTATIC HEATERS

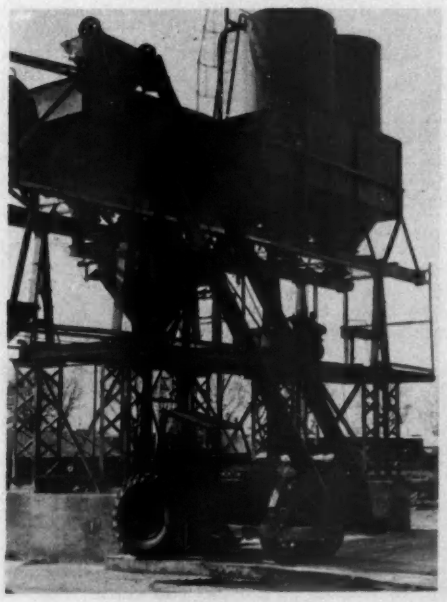
Three Thornycroft fabricated steel vertical oil-fuel heaters of the solid drawn steel hairpin tube type are fitted, each capable of raising 14,500 lb. of oil per hour through 200 deg. F. when supplied with steam at 225 lb. per sq. in. gauge. The steam supply for each heater is taken from the auxiliary main and is arranged for either hand control through a gunmetal slow-opening valve or through a gunmetal thermostatically controlled Drayton steam regulating valve. A further gunmetal valve is provided for isolation. Each heater is fitted with a steam drain assembly, also of gunmetal, which incorporates a changeover cock, one side being direct drain to bilge and the other side to a sight glass, strainer and Yarway steam trap, discharging to the existing observation tanks.

Each heater is fitted with a cast steel outlet valve discharging to a mild steel common main which terminates with three branches each connected to a cast steel discharge strainer inlet valve. Three independent self-cleaning plate type discharge strainers with fabricated steel bodies are fitted, each capable of passing 14,500 lb. per hour of hot oil at a working pressure of

450 lb. per sq. in. gauge. Three cast steel strainer outlet valves are connected to form a common outlet to the boilers.

Three branch lines, each serving two boilers, connect to the common outlet main. Each of the branch lines terminates with a T-piece, each branch serving one boiler front. Each boiler front manifold has a cast steel isolating valve, a cast steel Stephens quick-closing low water valve, six burner valves and a cast steel circulating valve, connecting with the existing hot oil return to settling tanks. The burner valves connect to the existing Thornycroft oil fuel burners, which are designed to work with pressures as high as 600 lb. per sq. in. gauge.

Each boiler room is fitted with a combustion control panel as already described, which is designed to centralise oil and air control to the burners. Also on the panel is the boiler room telegraph and answering bell. The panels are constructed of mild steel angle with mild steel covering plates, all galvanised or zinc-sprayed and finally covered with polished green or black stove enamel with matching trim and bezels in stainless steel. Each is illuminated with Philips fluorescent tubes. Allen West starters are provided for the pump motors.



The hoppers of a concrete batching plant being filled by a high-discharge overloader. The bucket is cable-pulled up the inclined rails from the loading position to the discharge level.

★ ★ ★

THERMOMETER FOR HYPOTHERMIA

Thermocouples give a convenient way of measuring the temperature at critical positions within the body during surgery. However, such equipment needs careful design to meet the particular conditions of the operating theatre. Some techniques, particularly hypothermia (low temperature surgery), call for high sensitivity.

W. G. Pye and Company, Limited, Cambridge, have recently supplied a three-channel recording thermometer to St. Erik's Hospital, Stockholm. It is to be used for temperature investigations during hypothermia. Three copper-constantan thermocouples are employed. They are attached to sites on the patient's body, and each is connected to a direct current amplifier. Alternative full-scale deflections of 0·2, 0·8 or 4·0 deg. C. are available.

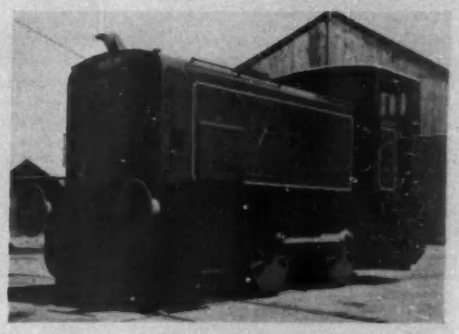
For checking performance, a "Scalamp" galvanometer is provided. It is suitably calibrated and matched to the thermocouples. Should the main electricity supply fail, the galvanometer replaces the direct current amplifiers. A 4 ft. cabinet on a trolley houses the equipment.

INDUSTRIAL DIESEL SHUNTING LOCOMOTIVE

Developed from the 165 DE Diesel-electric standard gauge shunting locomotive, Ruston and Hornsby Limited, Lincoln, have introduced the 200 DE, which is a more powerful version. One of these locomotives, which is shown in the illustration, was displayed at the recent Engineering and Marine Exhibition. It is made in two weights, 30 tons for the 0-4-0 wheel arrangement and 32 tons for the 0-6-0 arrangement. The two types cover the service duties of 14 in. and 16 in. steam locomotives.

The power unit is a Paxman 6 RPHL V form Diesel engine developing 210 b.h.p. at 1,250 r.p.m., driving a B.T.H. generator. The complete power unit is resiliently mounted by three-point suspension on the engine's sub-frame which is actually an integral part of the engine's main frame. Two locomotives can be coupled together and operated in tandem by one driver, providing a 420 h.p. shunter.

Accessibility is one of the main features of the design of the locomotive. The axle boxes are cast-steel single-flange type with separate thrust collars fixed to the axles to take the thrust. This is contrary to common practice where the thrust is taken on the wheels. The faces are lined with a renewable anti-friction material which can be replaced, when worn, without jacking up the locomotive. The internal position of the collars reduces the ingress of dirt and grit. The bronze bearing of the axle assembly is designed with its outside concentric, which enables a new bearing to be fitted by jacking the locomotive weight clear of the axle concerned, removing the axle-box keep and knocking the bearing round the axle.



For a weight of 30 tons, the 200 DE shunting locomotive has a maximum draw-bar pull of 21,460 lb.

The traction motor is nose suspended and is carried on and geared to the rear axle, the other axle or axles being driven by outside coupling rods. The motor is mounted with its axis at right angles to the road axle. The gearbox incorporates a spiral bevel and pinion for the first reduction and straight spur gears for the second reduction. Provision is made to disengage the gears from outside the gearbox by sliding the layshaft to one side. A Westinghouse direct air-brake is fitted with a hand screw-down parking brake operating on the same linkage. The maximum drawbar pull is 21,460 lb. falling to 1,340 lb. at a speed of 18 m.p.h. which is the normal service maximum.

HIGH-DISCHARGE OVERLOADER

The overloader shown in the accompanying illustration is claimed to have a higher level of discharge—26 ft.—than any other wheeled loader. As the illustration shows it will be a serious competitor to a system of conveyor belts or a long-jibbed crane using a grab bucket for loading the hoppers of concrete batching plant. It is a Merton overloader, powered by a Fordson Major four-cylinder Diesel engine and having six forward and two reverse gears. The ¾ cub. yard bucket is cable operated and travels from the digging to the discharge position on the fixed inclined rails.

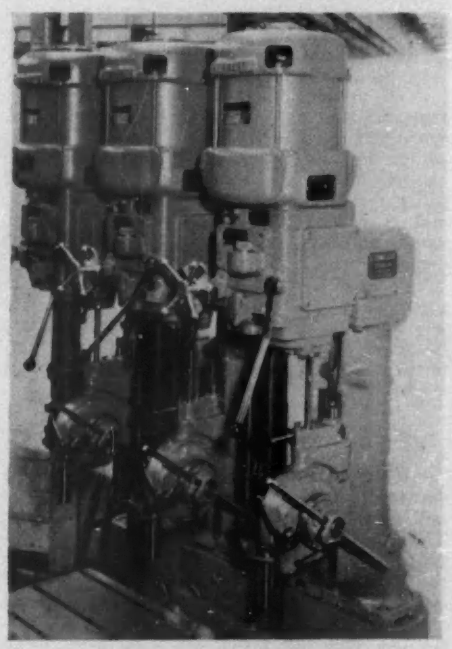
The United Kingdom agents for the machine are Mackay Industrial Equipment Limited, Faggs-road, Feltham, Middlesex, who have available for loan a short 16 mm. silent film which shows the overloader in use.

SIMPLIFIED SPEED CHANGE ON A DRILLING MACHINE

Up to the present the Type V drilling machine made by Alfred Herbert Limited, P.O. Box No. 30, Edgwick Works, Coventry, has been available in two forms; with a No. 2 Morse taper spindle and four speeds, controlled by a rotary switch, or with a No. 3 Morse taper spindle and an additional eight speeds, which are obtained by a sliding back gear in the drive gearbox.

Now, in order to obviate the necessity for stopping the spindle when changing from one speed range to the other, the eight-speed machine is being made with clutch-controlled gear range selection. Control of the four motor speeds is still by means of the rotary switch, but the back gearing is now of the constant-mesh type. Two multi-disc steel plate clutches are mounted between the drive motor and the spindle, coaxially with both. With the top clutch engaged and the lower one free, the drive is direct from the motor to the spindle. To operate in the lower speed range the hand-lever is used to engage the bottom clutch and free the top one; the drive is then through the back gearing.

The driving mechanism is totally enclosed and lubrication is by a plunger pump which cascades oil over the clutches and gears. Sintered carbon material is used on the faces of the clutch plates. Any one of the eight speeds can be engaged by means of the switch and the hand-lever, without stopping the machine. A separate hand-lever controls the starting, stopping and reversing of the machine, exactly as on the previous model.



Two clutches and back gearing make it possible for any one of eight speeds to be engaged without stopping the Herbert type V drilling machine.

Management

HOW GOOD ARE SOVIET ENGINEERS?

In this series of articles an attempt has been made to assess the Soviet engineer—by considering his status and background, his sources of information, his skill as a designer, and the way he manages a factory. The fifth article examines his approach to management. The series has been prepared by Mr. E. P. Ward, a Deputy Editor of ENGINEERING, *on the basis of a recent visit to the Soviet Union. A concluding article in the series, to be published next week, will summarise the writer's conclusions.*

5—HOW THE SOVIET ENGINEER PRACTISES MANAGEMENT

The term management embraces so many activities—administration, organisation, costing, psychology and a hundred others—that there is scarcely a section of these articles that cannot be considered under that heading. But in certain territories the manager is pre-eminent. The Soviet approach to costing, incentives and human relations is discussed in the following notes.

Organisation

Organisation is an essential feature of management, and in the Soviet Union appears to be studied systematically—almost as a separate branch of science. Thus a leading scientist may occasionally make a public statement on the organisation of research, not merely to analyse present methods but to propose new methods for the future. In the U.S.S.R., organisation is so closely linked with overall planning that the organisation of a factory can hardly be understood in isolation.

In 1955 Soviet industry comprised two sectors: 92 per cent. was state industry, while the remaining 8 per cent. was co-operative industry. Since 1937 there has been no significant private industry. Also in 1955, 53 per cent. of industry was under All-Union authority, while 47 per cent. was under republican, regional or district control. Since the decision to introduce some decentralisation and to establish 106 economic regions, the second percentage may be expected to increase.

Some idea of factory organisation may be gathered from the previous article in this series. Thus, at the First State Ball Bearing Factory (GPZ), production is organised in two sectors, one concerned with single and special items—one-off or batch production—and the other with mass production. There is also a division of responsibility between a chief engineer, who supervises production, and a chief technologist, who is concerned with processes. A similar division exists at the Sverdlov factory, where the chief of a shop (an engineer) has two deputies (both engineers). One deputy is responsible for organising production, and is assisted by a "chief master" and a number of "shift masters," usually techniks (technicians) but sometimes engineers. The second deputy, whose diploma is likely to be in "economic engineering," administers the planning and distribution of work between machine tools, and supervises the production planning office, where drawings are converted into machining instructions.

The overall direction of a factory may be in the hands of an administrator without technical qualification. Indeed, I saw on one director's office shelves, not the usual array of *passé* textbooks—residues of student days, but the collected works of Lenin—some 30 volumes long.

Costing

Ability to count the cost is a measure of good management. It is a means of checking waste and of selecting the best production methods. The cost of making any product should be commensurate with its value to the user, otherwise resources will be squandered. As a society advances, skill in costing becomes increasingly important, since as fundamental needs are satisfied and the goods available grow more numerous, so does the problem of choice become more difficult—not only to the consumer but to the producer too. Thus, once a starving man has satisfied his immediate hunger—at whatever cost—his choice of action becomes wider and less crucial. In industry, costing is the tool by which such marginal choices can be made.

Soviet economic philosophy is so different from ours, that a completely novel approach to costing might be expected. At one factory I inquired what was the basis of their costing system, and was told that it stemmed from Karl Marx's theory of surplus value. In an attempt to understand the Soviet point of view I skimmed through *Capital* and discovered that according to Marx the "value of a commodity [varied] directly as the quantity, and inversely as the productiveness, of the labour incorporated in it." It occurred to me that I might spend several hours unskilfully chiselling a piece of stone without producing anything of value; but later read that "if the thing is useless, so is the labour contained in it; the labour does not count as labour, and therefore creates no value." From this I gathered that an item might be valued in terms of the labour involved in its production, from the mining of raw materials to the sale of the finished article, but the process of valuation might be a lengthy one.

What I eventually came to understand by surplus value may be gathered from the following analogy—for which Marx was not responsible. A man living alone on a desert island will work a sufficient length of time to satisfy his needs, say, six hours a day. Now, if someone purchases the island and allows him to remain there only on the condition that he works 10 hours a day and supplies the owner with the produce of the extra four hours, then this extra labour represents the surplus value of the total product. Presumably the Soviet accountant knows what part of this surplus is to be returned to the worker and what retained for reinvestment, but his calculations must be very difficult when some labour is valued at 600 roubles a month and some at 6,000.

In fact when it comes to practice, the procedure seems very like our own. On asking at the same factory what were the actual steps in costing a product, I was told that a figure for plant depreciation was added to the cost of materials and labour, plus a further 3 per cent. Punched-card techniques and calculating machines are widely used, but I also saw in most cost offices an abaccus or two. I also learned that in any year a figure for net income would be fixed by Gosplan, the State Planning Commission, and that reinvestment would be permitted in the degree to which this target was exceeded. All profits are submitted to Gosplan, which returns a proportion for re-equipment. Such a system would certainly promote the expansion of the more efficient factories, just as higher gross profits do here.

Nevertheless, there is a noticeable difference in economic emphasis between the Soviet Union and Western countries. Where we are frugal, they are often extravagant, and conversely. Our underground railways are purely functional; theirs are elegantly decorated. Our clothes are stylish; theirs are practical. Comparisons are difficult. Two distinct exchange rates add to the confusion—26 roubles (tourist) and 11 roubles (trade) to the pound. A lb. of butter and a long-playing record cost roughly the same in the U.S.S.R., whereas in Britain one is nearly 10 times as dear as the other. Import or foreign currency restrictions have often led to the domestic manufacture of articles—watches, textiles, photocopies of ENGINEERING—which might otherwise be purchased more cheaply overseas. Gold, having little practical value, appears to be widely used in the decoration of statues or buildings in the Soviet Union, whereas in the West, because of its exchange value, it is kept hidden in vaults. Cars seem often wastefully big in Russia, though drivers frequently save petrol by freewheeling downhill.

One consequence of the difference in economic emphasis between East and West lies in the field of capital investment. All major capital resources are provided by the State, which recovers its expenditure through a general tithe on production. The procedure for collecting this tithe has already been explained. Since capital investment is centralised, the pressure to recover expended capital is diffuse; in other words there is a swings-and-roundabouts effect, with the Government prepared to suffer capital losses on certain projects.

The results of this policy seem to be mixed. In the West, for example, an airline is operated on a carefully costed basis, but in Russia I travelled twice in aircraft that were more than two-thirds empty. Long-distance telephone charges are comparatively high in Britain, whereas in the Soviet Union they appear to be relatively low. The Soviet attitude seems to be that once an item has been bought—an aircraft or a telephone network—the capital cost is written off and there is no special pressure to recover it. In the case of an aircraft, which has high running costs and depreciates much more rapidly when in flight, the Soviet approach seems to be wasteful; but in the case of a telephone system, which has a high initial cost and roughly constant running costs, whether it is used or not, the Soviet procedure may have an advantage. Thus in Britain telephone charges are established at a level calculated to give the maximum return, though not the greatest number of subscribers. In the Soviet Union, on the other hand, a nominal charge deters only a few potential callers. Thus whereas aircraft may not be put to maximum use in the Soviet Union, the telephone system probably is. It should be emphasised that these comments are meant in only the most general way, and the cases quoted are intended simply as illustrations.

But it is difficult to see how any effective measurement of demand can be made without the price mechanism as a guide. It is said that in most countries even in wartime a small black market is tolerated to serve as a standard by which prices may be judged. At the present stage of Soviet development, demand is so great

Soviet factories are decked with banners designed to encourage the worker, and to promote in him a sense of community. The poster appeals to young workers to be tireless in building Communism.

for many products, from capital equipment to consumer goods, that accuracy in costing may not be necessary; but eventually, when prosperity reaches a high level, a new and more precise technique will be required. Incidentally, one Russian told me that everybody studied Marx's *Capital* at school, but they found it pretty heavy going. So in fact did I.

Incentives

The Soviet approach to work encouragement appears to combine two main elements. One aim is to promote a sense of community, and the other to provide realistic incentives.

Every Soviet factory is scattered with slogans, every beam carries a banner or poster with a call to build Communism or to fulfil a quota. There appear to be certain grades of slogan, depending on the quality of labour employed. Thus whereas a manufacturing plant would display emotional appeals to patriotism, in the workshops of a research establishment a more rational approach might be adopted—" Increase output and raise living standards." I noticed that in only one workshop—where women were employed exclusively—was there a departure from the usual red poster; there they were blue. Another method is to display photographs of efficient workers in a prominent position at the factory gate or the entrance to a workshop. The numbers included on such a merit board would be between 20 and 100, sufficient to discourage the cynic from scoffing, in that his own face might appear at a later date, or at least his pal's. Badges indicating good progress are occasionally worn and orders awarded for outstanding work—the Stakhanovite principle is well known. Community sense is further fostered by housing schemes, works clubs, holiday resorts, hospital and other free services, associated with particular factories. Such facilities must also discourage workers from changing their jobs. The ZIL factory even produces its own daily paper, of which some 25,000 to 30,000 copies are distributed each day. It is significant that most people are Consomol members (Young Communists) until they are 28, though roughly only one in thirty ever become Party members. Finally there are the pictures of national leaders, which appear in all entrance halls, and offices, but whether the response to these was awe, fellow feeling or indifference I could not tell.

Piecework is widespread. All workers at the ball-bearing factory were said to be on piecework, while 60 per cent. of those at the Sverdlov factory and most of those at ZIL were also. Where piece rates are unpractical a progressive wage is established, as in an automatic flow line where tool setters are rewarded in inverse proportion to the number of bottlenecks in their section. Engineers, too, are awarded bonuses in accordance with the quality of their work.

Suggestions are rewarded under a complex but ingenious scheme. The table (right) was copied from a notice board in the ZIL factory and recognises three grades of proposal: a simple rationalisation, a more complex idea and a fundamental invention. Awards comprise a percentage of the economy effected by the suggestion, plus a fixed sum.

Finally, I noticed at one factory some workers dressed in what appeared to be highly coloured pyjamas, and was told that these men were sick and on " light duties." No doubt the conspicuousness of the costume serves to discourage malingerers.

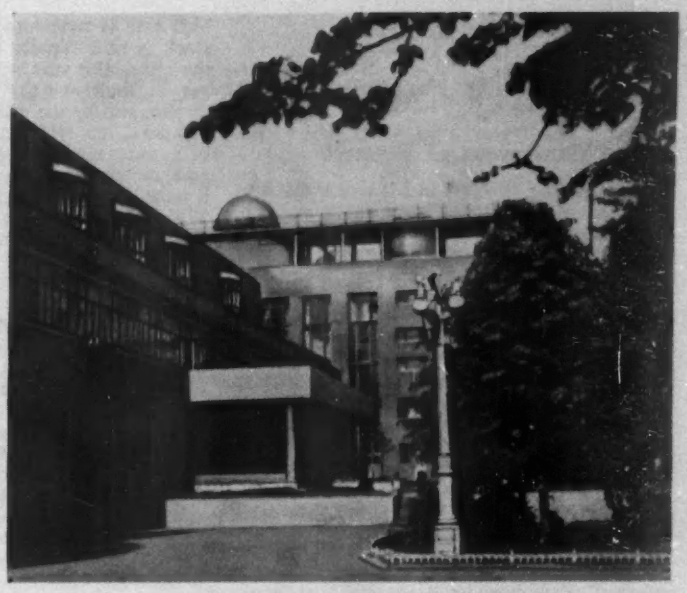
People

Management is fundamentally concerned with people, and one of its methods is to reconcile corporate with private aims. In the Soviet Union considerable efforts are made to foster this community of purpose, and factories are frequently self-contained colonies with all the necessary services. Thus the GPZ ball-bearing factory, with 10,000 workers has not only its own canteens and social club but also living quarters, kindergartens, nurseries and theatre.

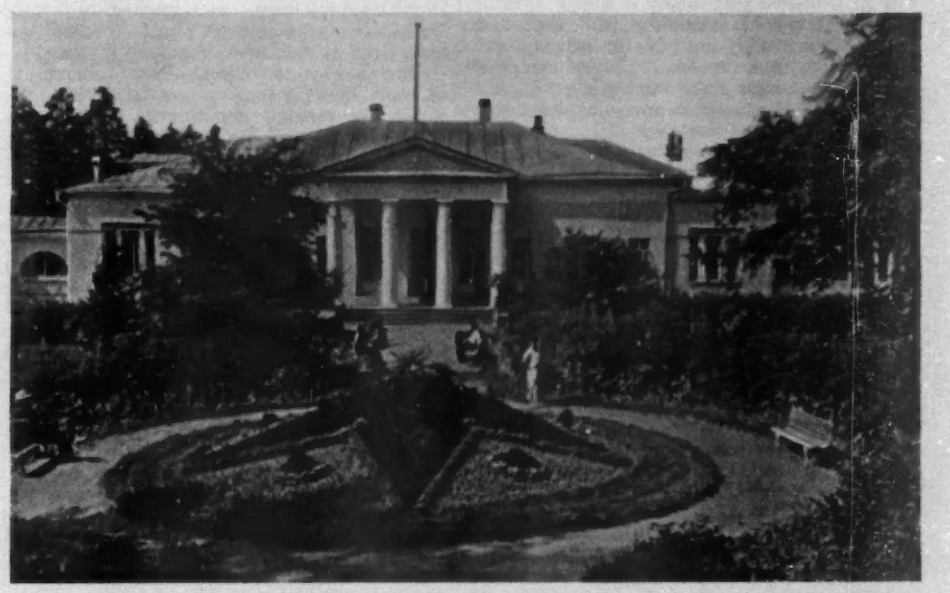
Similarly, the ZIL motor works, with 40,000 employees, has associated apartment houses, a large hospital, a dental surgery, sanatoria, schools, holiday camps, and the usual *dom kultura*. The house of culture includes a theatre and cinema, and the works has its own orchestra and choir. The Torpedo sports club is well known and successful, with 70 football teams, and 30 other sports teams. Activities include hunting, skating and fishing, but, I was told, no golf. There are three summer villages for children, Vachina and Mikhnevo, 70 km. from Moscow, and Myachikovo, 40 km. Two of them each have accommodation for 5,000 children. It would appear that all adult members of a family work, so that it is necessary to provide facilities for children during working hours. Each year ZIL builds 500 flats, and 50 million roubles are provided from the state budget for housing. A further 25 million roubles is given to the director for extending the *dom kultura*, for children's institutes and also for pensions. The minimum pension allowance is fixed at 300 roubles a month, which is little less than the minimum permitted wage, 370 roubles.

Trade unions do not appear to have the same power as unions in this country, but within the factory seem rather to correspond to the works-consultation committees already familiar in Britain. Trade-union representatives are responsible for welfare, and make recommendations to management on behalf of employees. When I asked about industrial disputes, I was told: " In our country we have no need of strikes." Recently new legislation has been introduced whereby workers may bring complaints before a People's Court.

(Right) The ZIL motor works is a self-contained community, with hospitals, schools, apartment houses and holiday resorts. Its dom kultura, *or social club, shown here, includes a cinema and theatre.*



(Below) Rest home associated with the ZIL factory, which also has its own summer villages for children. Two of the three villages have total accommodation for about 10,000 *children.*



Rewards for Inventions and Suggestions at the ZIL Motor Factory

Economy effected (roubles)	Awards		
	Fundamental invention (not less than 200 roubles)	Medium improvement (not less than 150 roubles)	Simple rationalisation (not less than 100 roubles)
Up to 1,000	30 per cent.	25 per cent.	12·5 per cent.
1,000 to 5,000	15 per cent. plus 100 roubles	12 per cent. plus 130 roubles	6 per cent. plus 65 roubles
5,000 „ 10,000	12 „ „ 250 „	8 „ „ 330 „	4 „ „ 170 „
10,000 „ 50,000	10 „ „ 450 „	5 „ „ 650 „	2·5 „ „ 350 „
50,000 „ 100,000	6 „ „ 2,500 „	3 „ „ 1,650 „	1·5 „ „ 850 „
100,000 „ 250,000	5 „ „ 3,500 „	2·5 „ „ 2,200 „	1·25 „ „ 1,100 „
250,000 „ 500,000	4 „ „ 6,000 „	2 „ „ 3,400 „	1 „ „ 1,700 „
500,000 „ 1,000,000	3 „ „ 11,000 „	1·5 „ „ 6,000 „	0·75 „ „ 3,000 „
Above million	2 „ „ 21,000 „	1 „ „ 11,000 „	0·5 „ „ 5,500 „
	but not more than 200,000 „	but not more than 100,000 „	but not more than 25,000 „

Continuing **Management**

Weekly Survey

Management of Research

Many managing directors find it very difficult to make even elementary decisions about research, and with every justification. How much, for example, should be spent on it, and in what proportion to other cost items? It is common practice nowadays to talk about the vast amount of "research" done by one's company—but are people talking about the same thing? Conscious of this, problem of definition, and of the need for a speedy application of research to management, the British Institute of Management are holding their twelfth national conference in Bournemouth on November 6 to 8, with the theme "Research—A Signpost to Better Management." The programme appears well thought out and down to earth, with speakers qualified by experience. The B.I.M., like those other bodies whose members can be described as the progressive cream of industry, are very research-minded. They consider it essential that, in the United Kingdom particularly, "a high level of research should be maintained, still more that it should be readily available to industry and applied without a time-lag." To do this it is essential to be clear about what is involved, and to know how to manage research and researchers —generally anything but easy.

Lord Monckton, who has probably done more for industry and has as keen an understanding of it as any lawyer of his generation, will give the opening address, with the B.I.M.'s chairman, Mr. Harold Wilmot of Beyer Peacock, in the chair. Most of the speakers and chairmen are drawn from the top level of industrial management, including many well-known engineers such as Dr. Rogan of the United Kingdom Atomic Energy Authority, Mr. John Ryan of the Metal Box Company, Mr. Bowman Scott of Solartron, Mr. F. W. Rowe of K. and L. Steelfounders, the Earl of Verulam of Enfield Rolling Mills, Mr. Edward L. Denny of William Denny and Brothers, Mr. Buckman of Standard Motors, Mr. Anscombe of Joseph Lucas, Mr. W. H. McFadzean of B.I.C.C., and many others. Also included are specialists in various types of research—metallurgical, chemical, operational, financial, management, marketing, and so on. Over 1,000 top managers from all sections of industry and from all parts of industry are expected to attend, some with their wives, for whom there will be a special programme.

★ ★ ★

British Railways Train the Middle Aged

Young men are preferred to the middle aged and elderly when it is a question of teaching new skills and techniques. But if the young are not available in sufficient numbers, those who are thin on top may have to be accepted. That age is far from being an insuperable barrier, however, is being amply demonstrated by British Railways in the course of training men for operating and maintaining the new Diesel rail-cars. By a set of curious chances the average age of these men is high.

The steam locomotive tradition is that drivers start as cleaners before they are given the opportunity to fire and later to drive, and they do not work on the footplate of express passenger engines until they have done some years on lesser engines. Thus the average age of drivers who are selected for Diesel rail-cars is perhaps 45; some are nearer 60 than 50 when they are sent on the fortnight's course. Men in supervisory or staff positions who are given special training also tend to be middle aged, for reasons of seniority. The only group of men whose ages are more widely scattered are the fitters.

Since the first of the schools for drivers and fitters was opened at Derby two years ago, over a thousand men have passed through. Such a high rate is necessary because the new rolling stock is now rapidly coming into service. By the end of this year more than 1,450 vehicles for use in multiple-unit Diesel trains will be in service, and by the end of next year the number will be 2,700. The course for drivers consists of a week in the classroom on the mechanical and electrical features of rail-cars, followed by a week on the line to acquire facility in driving. When the men return to their depots they find the conditions of work vastly different from what they have been used to on steam locomotives. Apart from the greater cleanliness, a driver now requires only 15 minutes from booking on at the shed to driving off, compared with about an hour for a steam engine. On the Crewe to Derby run, for example, this means that a driver does four runs (two each way) in a day, instead of two runs. He has no fireman with him, but he is closer to the passengers, being separated from them only by a glass panel. He has to know how to cope with minor breakdowns and how to cut out one engine and transmission so as to get home on the others. Some of the men have already been driving Diesel rail-cars before they are sent on the course, and a few find after the course that they have to continue on steam for a while before there is a Diesel train for them. Men selected for driving Diesel locomotives are not sent to a school but are trained at their home depot.

Supervisors and officers—from foremen to assistant works managers—are taken from the works and running departments and given a course at the Staff Training College at Derby, where a new Diesel building has been put up, with ample equipment including engines, and electric, hydraulic and mechanical transmissions. These courses are from two to five weeks in duration.

The Diesel training programme of British Railways is complicated by the fact that many makes and types of vehicle are being ordered from all the principal British makers. Standardisation of rolling stock is farther off than it ever was with the steam locomotive.

★ ★ ★

Industry and the Free Trade Area

A joint report on the "European Free Trade Area" has been put out under the auspices of the Association of British Chambers of Commerce, the Federation of British Industries and the National Union of Manufacturers. If this report represents the attitude of British industry as a whole (and it may be a major proviso) there is some hope that the Free Trade Area will at least get an intelligent hearing. The report is concerned only with what ought to be negotiated into a treaty and what ought to be left out if a treaty to establish a Free Trade Area is put into negotiation.

The report is quite firm that it does not favour a Free Trade Area at any price. In other words, it does not subscribe to the view that the Free Trade Area is inevitable because the European Economic Community (established by the Treaty of Rome) is already a fact. It goes on to say that the matters which should be covered by a Free Trade Area convention should include tariffs and import restrictions, definitions of origin, government intervention, export subsidies and incentives, no discrimination in transport, government export restrictions, dumping and the taking of appropriate measures to help hard-hit industries and companies. Matters which should not be covered by the convention, in the view of the report, include taxation matters, harmonisation of wages and social charges, restrictive practices and transport policy.

Inevitably a document of this kind is the lowest common denominator of three groups of trade associations which have had to take a view against a background of changing circumstances and opinion. Since the F.B.I. produced the rather surprisingly favourable result of its questionnaire to industry on the Free Trade Area, the Treaty of Rome has been signed setting up the European Economic Community and business men have a better chance of seeing what they may be in for. It cannot be assumed that trade and industry are as favourably disposed to the Free Trade Area as they were a year ago. Furthermore, this report is quite categorical about there being no package deal at the diplomatic level on the harmonisation of wages and social charges—a subject on which the trade unions are likely to be just as adamant. This issue, so dear to the French, may be the one which gives most trouble in the Free Trade Area negotiations which are now warming up after the summer recess.

★ ★ ★

Free Trade with Canada

The proposal which was aired before the Commonwealth Finance Ministers met formally in Canada last week that there should be a free trade arrangement between the United Kingdom and Canada bristles with difficulties. The new Canadian Government is reputed to be concerned about the high level of United States investment in Canada and the dependence of Canada on the United States market for its exports despite the buoyancy of the Canadian against the United States dollar. Free trade between Canada and the United Kingdom will be a difficult idea to work out in practice, for these arrangements work best between homogeneous industrial groups where there can be a certain amount of give and take.

Canada sends mainly commodities into this country and there is little scope for flexibility unless this country is prepared to revise its farming subsidies. Similarly, on the Canadian side there are political difficulties in allowing British goods in free of tax. Canada has a number of small industries which could not survive at present without tariff protection. It may be true that the level of Canadian mineral resources is such that an industrial revolution can be generated without protecting small industries but such is a bold long-term view for a political party which has still to reinforce its popularity with the electorate.

As a gesture towards freer trade at a time when Free Trade Area discussions are hung up, Canadian proposals have some merit. How far the whole idea is a political and economic throwback to the old days of Imperial preference and how far it is the dawn of a new free trade age in the Commonwealth remains to be seen.

★ ★ ★

First Year of the I.F.C.

The International Finance Corporation has published its first annual report and can record total commitments of about 6 million dols. in its first year's performance out of a total value represented by the enterprises in which it is interested of 34 million dols. Between 25 and 30 proposals are now under examination, most of them in Latin America where the first four schemes have been arranged. Mr. Robert L. Garner, the president of the Corporation, points out in his address that the large preponderance of Latin American schemes in the early stages does not represent the Corporation's policy but merely that these particular proposals can be quickly got to an advanced stage.

It will be recalled that the I.F.C. exists to invest in projects which do not have government backing and where there is a larger element of risk than in the kind of schemes in which the World Bank participates. It resembles the World Bank in its procedures, however, in as much as it takes part to only a limited extent in ventures which local enterprise and capital must be the first to sponsor.

Mr. Garner points out in his address to the 51 member governments (who have subscribed together about 92 million dols. to set up the

Corporation) that the organisation is concentrating on " the fields of manufacture, processing and mining, which provide the greatest economic multiplier, through employment, training, and stimulation of associated activities, and which most widely attract the flow of private capital and management skills." The Corporation is setting a maximum of 2 million dols. to its participation at any one time and is taking 500,000 dols. as the minimum size of projects in which it will become interested for the time being which means a participation of about 80 per cent.

The main enterprises under consideration at the moment include pulp, paper and forest products, textiles, agriculture, constructional machinery, chemicals, food processing, cement, mining and printing. Apart from the, perhaps inevitable, unfavourable geographical bias in its early stages, the Corporation has got away to a good start after some initial reluctance on the part of some member-countries of the World Bank to put up the money. It will probably take an initial five-year period for the Corporation's work to be assessed at all objectively.

★ ★ ★

How to Grow Big

The recent firm measures taken by the Government to restrict Bank finance is a threat to expanding small businesses. They may now be driven even more quickly into groups where collective activity makes everything easier—financing, research, marketing, and other operations. But it is a pity the small man of enterprise should be dependent to this extent. Yet our tax laws are such that more and more small businesses are born each year, and there is always the outstanding success to encourage the newcomers. One example is Solartron, whose monthly sales rose from £1,500 in 1950 to £100,000 in 1956. Another is Hurseal, the manufacturers of space heating appliances and equipment, who are now on the threshold of bigness. Their managing director, Mr. A. C. Hazel, spoke in Oxford recently (to the University Business Insurance School) on " The Problems of a Smaller Business." He generalised from his own personal experience, but what he said will sound sense to most and is widely applicable.

First, a smaller manufacturer cannot hope to break into the competitive market in a day unless he produces " completely original products." This does not necessarily mean a product he had developed but one not made by any large firm. Mr. Hazel considers that for a smaller manufacturer to attempt to compete with such firms is a struggle too unequal to be attempted: " the big manufacturers would be able to lose him on price and kill him with advertising." Secondly, what the small man makes must be made in a manner which allows him to hold his lead as first-off-the-mark. He must therefore concentrate on a comparatively small number of highly specialised products and therefore attain " tremendous economy in production methods." This is one way of saying that the small man hasn't much of a chance unless he matches the quantities of the big man on a restricted front. Thirdly, the small manufacturer must retain the big advantage of the one-man firm over the big group, that of rapid decision and action, so that " the items could be developed more quickly and articles put into production more easily."

Mr. Hazel did not attempt to disguise the difficulty facing the small man even if he succeeds in meeting the three prerequisites of success just outlined. He must be a good salesman, he must ride on the crest of the wave (of public acceptance of his product, for he cannot afford any mass educative or widespread advertising), and he must find lenders. All this is fine, but hard and anxious work. For his part, Mr. Hazel " cannot wait for the day when I can regard myself as no longer a comparatively small business man."

Marketing

PROMOTING TRADE WITH CANADA

The attempt to increase United Kingdom-Canada trade has got off to a bad start. Initially, Mr. Diefenbaker's statement that 15 per cent. of Canada's trade would be diverted to Britain was greeted with incredulity. The links with the United States, it was argued, were too strong to allow so radical a change of trading direction. United States investment in Canadian industry stood at 7,500 million dols. (book value) by the end of 1956, amounting to 82 per cent. of total foreign investment in Canadian industry. The United States investment had increased by 900 million dols. in 1956 alone and the proportion of the total rose even further during the first six months of this year. The latest figure available shows that, at the end of 1954, United States interests controlled 48 per cent. of the mining and oil industries and this proportion has been increased substantially in the past 2½ years.

This Canadian dependence on United States capital for the realisation of her industrialisation programme goes far to explain industry's reaction to Mr. Thorneycroft's free trade proposal made at the conference of Commonwealth finance ministers at Mont Tremblant, Quebec. The discrimination against United States exporters which is involved is distasteful enough, but the thought of having to compete with British industries on level terms has horrified Canadian business. The reaction to Mr. Thorneycroft's proposal is evidence that, in their own opinion, Canadian industrialists would be unable to compete without tariff protection. Electrical engineering, some sections of the steel-fabricating industries, textiles and footwear are the most vulnerable and therefore the most vocal in their protests. In the circumstances it is most unlikely that the British proposal can be accepted and doubtful if United Kingdom-Canada trade can in fact be raised to 15 per cent. of the total.

★ ★ ★

Canadian Mission

Among all the flurried comment on free trade the publication of a sober review of the export prospects of the British manufacturers of petroleum equipment has been published by their Council. The C.B.M.P.E.'s " Report of the Economic, Technical and Goodwill Mission to Canada " (12*s.* 6*d.*) is a most instructive document. The Storey Mission, as it has been called by Mr. Derek Walker-Smith, formerly Minister of State, Board of Trade, included representatives of most of the major suppliers of petroleum equipment under the leadership of Mr. J. M. Storey, managing director of Dewrance and Company.

The mission's main conclusion is clear enough: the Canadian market for this type of plant is large and expanding and Britain's share of it very small. According to Mr. Walker-Smith (who writes the foreword), " energetic sales efforts must be made by British firms wishing to do business with Canada, but for those who tackle the job courageously there is the reward of a solid and expanding long-term market."

Oil and petro-chemical industries in Canada are spending 700 million dols. a year on the type of equipment manufactured by the C.B.M.P.E. members, rising to an average of 1,000 million dols. annually over the next few years. Only 7 per cent. of refining and processing equipment was purchased from Britain, but 50 per cent. came from the United States. In drilling and production the equipment is overwhelmingly of United States origin (98 per cent.). Yet the price and quality of British products was found to be competitive. The principal reasons limiting the volume of United Kingdom sales in the past were given as " relatively long delivery periods and lack of service outside the major outlets "; also, " there is need for very active and aggressive selling."

★ ★ ★

Selling in Canada

Some of the recommendations of the C.B.M.P.E. report on marketing methods are very specific and leave no room for illusions. There is no point, they say, to enter the market at all unless " competitive delivery periods can be offered and maintained." These are up to three months for routine purchases, up to nine months for capital goods and up to a year or 15 months for certain goods in short supply, such as large rotating machinery.

The market might be approached initially through agents, but " the ultimate goal is maximum manufacture in Canada, achieved through the intermediate stages of direct representation, local assembly and part manufacture." There is no ambiguity about what must be done to succeed: from the very beginning it is essential to (*a*) maintain adequate stocks of products (where applicable) and of spare parts, (*b*) have representatives fully conversant with the product and the application, and (*c*) provide adequate technical sales literature and establish channels for quickest possible dealings with inquiries and technical questions which have to be referred to the works. It is also important to pay careful attention to location: Calgary or Edmonton for oilfield equipment; Toronto for refineries, petro-chemical works and pipelines. One of the more salutary comments by the Storey Mission was that " even the largest British manufacturers with world-wide reputations do not appear to be known in some parts of Canada."

★ ★ ★

Vancouver Fair

An international trade fair will be held in Vancouver next May to mark the centenary of the creation of British Columbia as a Crown Colony. In his announcement of this, the Agent General for British Columbia in London points out that British firms made an important contribution to Canada's import requirements of capital equipment and machinery. These include steel rails and angle bars supplied by United Steel to the Pacific Great Eastern Railway; pipe for the west coast Transmission Company's 650-mile natural gas pipeline sold by the South Durham Steel and Iron Company; transformers by Ferranti for the Kemano powerhouse of A.L.C.O.; 91 miles of submarine cable by B.I.C.C. for the B.C. Electric Company, and others.

The announcement lists " openings " for British manufacturers including " marketable items " such as metal office furniture, railway rolling stock, sheet glass, business machines, electrical apparatus and supplies and a wide variety of consumer goods. A trade delegation headed by the Minister of Industrial Development, Trade and Commerce arrived in London on October 1 to visit the chief industrial centres to promote interest in the Vancouver Fair.

★ ★ ★

Competition in Hand Tools

Fierce competition is forecast between Britain and Germany for the hand-tool markets of Europe. A leading American manufacturer, Mr. H. C. Pease, vice-president of the Stanley Works, New Britain, U.S.A., commented after a visit to Western Germany that manufacturers

in that country "are tooled up with the most modern equipment obtainable," and that they are going to be formidable opponents, "especially if, and when, the European Free Trade Area starts to operate."

The purpose of Mr. Pease's visit to England was to see the progress being made with the new Stanley Hammer Factory which is being built at Ecclesfield and due to start production towards the end of the year. Mr. Pease was not greatly worried about his own company's ability to compete in western Europe. Provided management is of good quality and alive to their opportunities he does not think there is very much to fear, and any removal of obstacles to trade will help.

★ ★ ★

International Transport

To get goods to their destination quickly enough in the increasing tempo of modern business is a necessity emphasised by practically all visitors to highly competitive overseas markets. Canada is a case in point, the United States even more so. This may explain the fact that recent air-freight traffic handled by B.O.A.C. has greatly increased of late, particularly from the United States to the United Kingdom. The amount of freight carried in that direction in July and August was 36 per cent. greater than in the corresponding two months of 1956—261,700 lb. compared with 192,964 lb.

The need for speed in delivery was emphasised in a brochure recently published by the Anglo-Overseas Transport Company describing their services to the United States which link up with the American Railway Express Agency. Although surface routes are used, the emphasis is placed on international airlines and Air Express internal United States services. Even small firms are becoming air conscious: Winston Electronics of Shepperton, Middlesex, announced that they were going to take advantage of the interest expressed in their tape recorder exhibits by flying out production models to their North American distributors for showing at the Canadian Institution of Radio Engineers Exhibition held at Toronto in mid-October. By way of contrast, but emphasising the same point, Henry Hope and Sons have despatched seven tons of steel windows to Holland "straight from works to building sites" by their own lorries.

★ ★ ★

Demand for Tractors

Evidence that an immense potential exists in world markets for agricultural tractors has been provided by the placing of a very large order by Yugoslavia and by Finland's decision to buy as many David Brown tractors as can be allocated "between now and the spring season."

The Yugoslav order is for 1,000 Perkins-engined Ferguson tractors and accessories and for 6,500 Ferguson implements. The engine will be the P3, and, in addition, Perkins have received an order for 600 P4 engines for installation in the Yugoslav-built Zadrugar tractor. These orders are the culmination of an intensive sales campaign on the part of both companies concerned, Massey-Harris-Ferguson and Perkins. Between them they have received Yugoslav orders totalling £7·85 million since 1955 following a decision by Yugoslavia to standardise on Perkins engines for their home-produced and imported tractors.

David Brown's position in Finland is similarly very satisfactory. The decision of the Finnish Government to lift import restrictions is likely to let in considerable quantities of farm machinery which is urgently required. David Brown, who already have a heavy order book for their tractor, are preparing a delivery schedule in consultation with their Finnish distributors. Ransomes Sims and Jefferies have just received an order for 280 of their MG.6 tractors for use on French vineyards. Overall, tractor exports are booming and Britain's position very much at the head of the world suppliers.

Research and Development

MATERIALS AND MICROWAVES

EXTENSIVE PROGRAMME AT MULLARD RESEARCH LABORATORIES

Photographic exposures of 3×10^{-9} sec. and the study of nocturnal animals in their natural habitat are two of the applications found for infra-red image converter tubes. Development of such tubes, and of their applications, occupy part of the research programme at the Mullard Research Laboratories, Salfords, Surrey. Recently, on the completion of new buildings, open days were held to show the scope of the work there.

The main addition is a two-storey laboratory building flanked by a four-storey office block, giving a total of 28,000 sq. ft. of floor space. Of this, laboratories occupy some 18,000 sq. ft. The total staff numbers about 700. About 175 of these hold degrees in engineering or physics.

The infra-red converter tube is an electronic device that converts infra-red radiation into visible light. Thus, if an object is "illuminated" solely by infra-red radiation it is invisible to the unaided eye, but if viewed through the converter tube the object appears as an image on a fluorescent screen. The applications possible for the device include the filming of nocturnal creatures in infra red (so avoiding the change in behaviour that would be caused by normal floodlighting), direct photography of the vein structure of the body (the skin is transparent to infra red), and the detection of mechanical defects in unexposed film. Because the tube only operates with the correct voltage applied, it is possible to view objects for extremely short intervals by switching the voltage on for the interval required. Using co-axial lines, exposure times of 3×10^{-9} sec. have been achieved and used to photograph the development of a spark discharge with remarkable success.

One of the major Government projects that has been carried out at Salfords has been the development of an airborne radar system operating at 36,000 Mc/s (a wavelength of 8 mm.—the "Q" band). The equipment is contained within cylindrical, pressurised containers with integral heat exchangers. By operating at such a short wavelength the definition is increased until it is comparable with the human eye. With the equipment a house can be picked out at a distance of 20 miles, and it is possible to identify an aircraft appearing on the screen as a particular type.

The transmitter is a pulsed magnetron with a peak power of 30 kW. It is a comment on the difficulty of getting apparatus to work at such extremely high frequencies that the modulator, a line-type hydrogen thyratron, has to provide a peak power output of 200 kW.

Experiments are also under way on travelling-wave tubes for use at the wavelength of 8 mm. A tube with a conventional spiral slow-wave structure was produced but the engineering difficulties in its construction lead to the production of an alternative type of slow-wave device—the inter-digital line. This is composed of "hairpins" made up in ladder form from gold-plated molybdenum wire, using established techniques of vacuum-tube grid winding. The ladder having been formed, it is brazed into a copper block. Two such blocks are then assembled to form the completed line within a waveguide. Matching of the inter-digital line to the terminal waveguides is achieved by tapering the length of the hairpins.

Much of the work at the laboratories is concerned with solid state physics and the associated devices—transistors and ferrities. An alloy diffusion process has been developed for the production of transistors. When they are produced in this way the transistors can be used at much higher frequencies than have hitherto been possible.

One of the main parameters that fixes the upper frequency limit is the thickness of the control-base region. In the alloy-diffusion process, as applied to germanium, a small mass containing both n-type and p-type impurities is heated and kept molten in contact with one surface of a p-type crystal. The n-type impurities diffuse faster in germanium than the p-type, and the base width is determined by the difference in the diffusion depth of the two impurities. The p-type impurity is so chosen that on cooling and solidification of the molten mass the recrystallised region is a good p-type emitter. Thus a p-n-p transistor is made in one basic step. The process outlined has been adapted in detail to meet a specific requirement of a transistor for amplification at 100 Mc/s. A neutralised power gain of 10 dB is obtained at this frequency. The base layer is about 2 microns thick. Transistors have been produced in the laboratory with switching times of 50 millimicroseconds, but their commercial production is not economical yet.

Much work is being done to develop measuring techniques for the new transistors. At present accuracies of between 2 and 5 per cent. are possible at frequencies up to 10 Mc/s and efforts are being made to extend the range to 200 Mc/s.

Work is in progress on the production and properties of single crystal ferrites. These include manganese ferrite ($MnFe_2O_4$), cobalt ferrite ($CoFe_2O_4$), mixed manganese-cobalt ferrites, nickel oxide (NiO), and magnetite (Fe_3O_4), the melting points being between 1,550 and 1,900 deg. C. The crystals are used for research on the ferro-magnetic properties of these oxides, including the phenomena of magnetic resonance. This occurs when a piece of ferrite in a magnetic field is placed in the path of microwave radiation. At a critical value of the field, the piece of ferrite absorbs microwave radiation strongly. The effect is due to the occurrence of gyromagnetic resonance of certain electrons in the ferrite. Under the correct conditions the magnetic resonance can be used to produce power amplification of microwave radiation (ENGINEERING, page 59, July 12, 1957), and for this purpose single crystals are essential. It is possible that the single crystals that are now mainly used for research in the laboratory will in the future become of great practical value in the field of microwave amplifiers.

The crystals are produced by two processes. One, the Verneuil, allows finely powdered raw material to fall through an oxy-gas flame on to a pedestal standing in the flame. The material melts and gradually builds up a boule of material. By slowly lowering the boule as it grows, its top is kept always in the hottest part of the flame. In the second method, the materials are fused in a platinum crucible in a high-temperature electric furnace and crystallised by very slow cooling. Crystals grown by the two methods are about 1 cm. in diameter and vary between 5 and 10 cm. in length.

Continuing **Research and Development**

ADVANCES IN AERONAUTICS*

By W. H. Stephens, M.SC., F.R.AE.S.†

The first half-century of the modern aeronautical age is counted from the historic date in 1903 when the Wright brothers, in North Carolina, U.S.A., succeeded in flying an aeroplane which lifted itself by its own power and was capable of sustained flight. Their success followed a long period of intensive study and experiment with wind-tunnel and model flight experiments. From studies of aerodynamics, thermodynamics and structural design, they produced a practical working aeroplane. This lesson is still valid to-day and, in discussing advances in aeronautics, it is of interest to recognise the problems which face us and to describe some of the methods now being used to surmount them. Since the human pilot meets conditions in supersonic flight which tax his physical capabilities, and will do so still more when space flight is attempted, I will also touch on human factors relevant to high-speed flight.

In Fig. 1 are plotted the trend of air-speed records and crusing speeds of civil airliners since 1920; the figure also includes some points for the American Bell X1 experimental aircraft and a point for the Fairey Delta, holder of the world air-speed record. The astounding feature of the curves is their slope, from which one might estimate that in ten years time the speed record may top 2,000 m.p.h. and long-range civil aircraft may cruise at 800 to 850 m.p.h., well above the speed of sound.

In the development of rockets and guided missiles, progress has been equally spectacular. It is indeed a far cry from the small artillery bombardment rockets used for ship-to-shore bombardment in the Crimean War to the V2 and the intercontinental ballistic missile. Rocket speeds have risen from medium subsonic values to 3,500 m.p.h. for the V2 and 15,000 m.p.h. which a simple calculation shows must be achieved by the 5,000 mile range intercontinental ballistic missile. During this same period, for the exploration of the upper atmosphere, instrument payloads from 50 to 500 lb. have been lifted by research rockets to heights of 250 miles above the surface of the earth; and an intensive effort to extend scientific investigation of the fringes of outer space is now in progress as part of the scientific activities of the International Geophysical Year.

The problems of aerodynamic drag and kinetic heating typify the mixture of science, practical engineering and large-scale experimental work which are necessary to achieve the tempo of development illustrated by the previous remarks.

OVER THE DRAG BARRIER

With the continuous quest for ever-increasing speeds, the conquest of the so-called " sonic barrier " has occupied a great deal of research effort in the aerodynamic field over a number of years. The term " sonic barrier " implies, of course, not an insurmountable barrier to speed increase, but the phenomenon of a very pronounced rise in drag (or aerodynamic resistance) as flight speeds approach the speed of sound. A body propelled through the air displaces air particles, producing (i) compression near its front end where air is pushed out of the way; (ii) expansion over its middle part where air particles have large relative velocity while the body slips through; and (iii) another compression near the rear end where air particles close in. A feature of subsonic flow is that the compressions are gradual and continuous so that when there is pressure over forward-facing surfaces (drag), there is also pressure over rearward-facing surfaces (thrust) so that altogether pressure and suction forces balance out and no drag remains, apart from viscous effects which themselves, of course, give rise to quite high drag at high subsonic speeds. In supersonic flow, the compressions may be discontinuous and take the form of shock waves, involving increase of entropy and hence a drag force. The first compression is localised near the nose, so that the pressure over forward-facing surfaces is high. The rear compression is localised near the trailing edge so that the pressure over rearward-facing surfaces is low. The combined effect is an increase of drag in the transonic Mach number range, usually beginning at some subsonic (critical) Mach number when regions of local supersonic flow first appear.

A typical curve of lift/drag ratio for an aircraft fuselage with an unswept wing is shown as curve A of Fig. 2. The lift/drag ratio includes, in addition to flow displacement effects, effects associated with the production of lift by the wing. The aim must be to keep L/D as high as possible; its value affects both range and cost of operation. The example shows that the drag rise is accompanied by a sharp fall in L/D.

The magnitude of the drag rise and accompanying fall in L/D can be reduced by using thinner wing sections—this clearly reduces the flow displacement involved. Recent aircraft design shows this general trend towards thinner wings, but they bring some structural penalties and certain aerodynamic complications associated with the efficiency of the wing as a lifting surface.

By the use of swept-back wings, the drag rise can, in part, be postponed to higher Mach numbers. This happens because the displacement effects are determined principally by the component flow normal to the leading edge, which can remain subsonic in type, even though the main flow is supersonic. A typical example of a highly-swept wing is shown in Fig. 2 (curve B).

Although the result for configuration B shows a marked improvement over that for the unswept wing, it is clear that, just above Mach 1, the full benefit of subsonic-type flow is not being achieved. This is mainly due to imperfections of the flow near the wing root, where in effect the sweepback is lost. To remedy this, the fuselage can, in principle, be so shaped that it produces a wave system which lowers pressures over the forward-facing wing surface and raises pressures over the rearward-facing surface. Wing-root drag rise is thereby eliminated and sweepback effect restored. The third curve (C) in Fig. 2 shows what in theory can be achieved by this means.

Here we have given, in substance the argument behind the theory of waisted bodies and the so-called " area rule." The principles of area rule can be applied to more complicated configurations than a simple wing/body combination, i.e. they may be adapted to the complete aircraft layout, including engine nacelles, cockpit, tail surfaces and so on. In all cases, the attempt is to arrange the shaping and juxtapositioning of a number of bodies so that interference between the separate flow fields is favourable to the reduction of drag.

This matching process can be extended up within the supersonic range, but in practice not without limit. The higher the Mach number, the more difficult it becomes to match a flat wing to a round body. At some stage we require to effect a transition to more integrated overall shapes, for example, a round fuselage with an annular wing around it, which might have an application to missile design.

If aircraft stability and control are to be maintained, it is undesirable that the type of flow should alter radically at any stage within the speed range, for example, by the onset of detached flow. The old low-speed aircraft, with a thick unswept wing of high aspect ratio, fulfilled the condition of maintaining the same type of flow throughout its speed range; the flow separated only along the trailing edge.

As the cruise Mach number increases it becomes more difficult to obtain a configuration which will also meet take-off and landing requirements. Both the thin wing and the highly swept planform tend to make it impossible to keep the flow attached to the leading edge at the high incidence required at low speeds. A possible solution to this difficult problem is the use of wings incorporating highly swept leading edges, with which one may consider creating and maintaining throughout the flight range a type of flow which involves flow separation along all edges. A typical example is the case of the slender delta wing, which is shown diagrammatically in Fig. 3. With separation from all edges, vorticity is shed along all edges and the resulting trailing vortex-sheet coils up above the wing surface. This type of flow has been observed to be stable; it is possible as long as the leading edge and the vortex sheets lie well within the Mach cone. To deal with such flows, a new aerofoil theory is required, distinct from the classical aerofoil theory which holds for wings with trailing edge separation only. Work so far has shown that the lift force is no longer a linear function of the angle of incidence but rises more steeply; and that the drag force due to lift is roughly proportional to the lift times the angle of incidence. The aim throughout the flight range is, therefore, to create the lift force at the smallest possible angle of incidence.

By the nature of such a flow, the lift force is created not so much by suction forces on the upper surface as by pressures on the lower surface, as the wings become more slender at the higher Mach numbers. In fact, the solution for wings of very small aspect ratio approaches that for a Newtonian fluid, and vorticity-shedding from side edges becomes the only means of producing a sufficiently large lift force. Thus

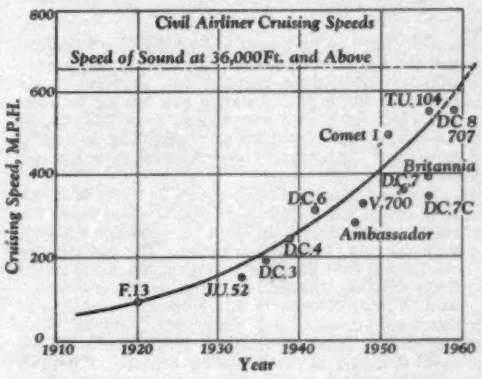


Fig. 1 Trends in aircraft speeds. The rise in speed is increasingly rapid as time goes on.

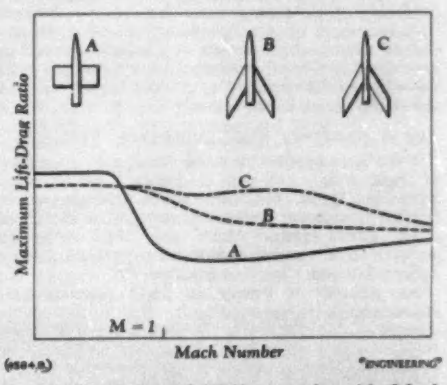


Fig. 2 Variation of lift/drag ratio with Mach number. Wing sweepback and body shaping are beneficial at moderate supersonic speeds.

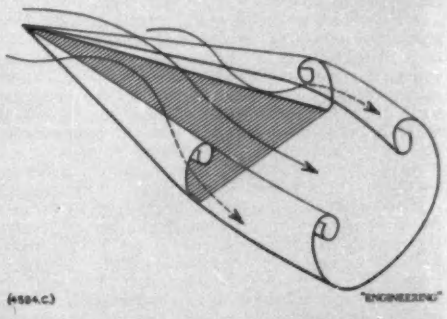


Fig. 3 Flow over a sharp-edged slender wing at incidence. Stable vortex coils occur above the wing.

* Paper to be read before the British Association, Section G, meeting in Dublin on September 9.

† Deputy Director, Royal Aircraft Establishment, Farnborough, Hants.

Continuing Research and Development

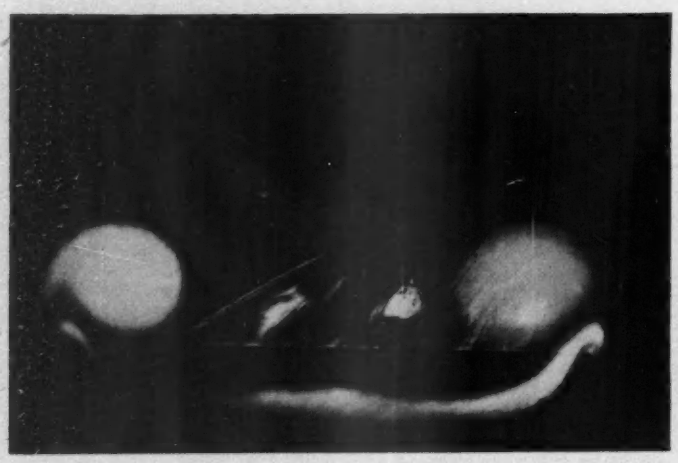


Fig. 4 (left) Vortex formation over thin swept-back wing revealed by smoke pattern in a wind tunnel.

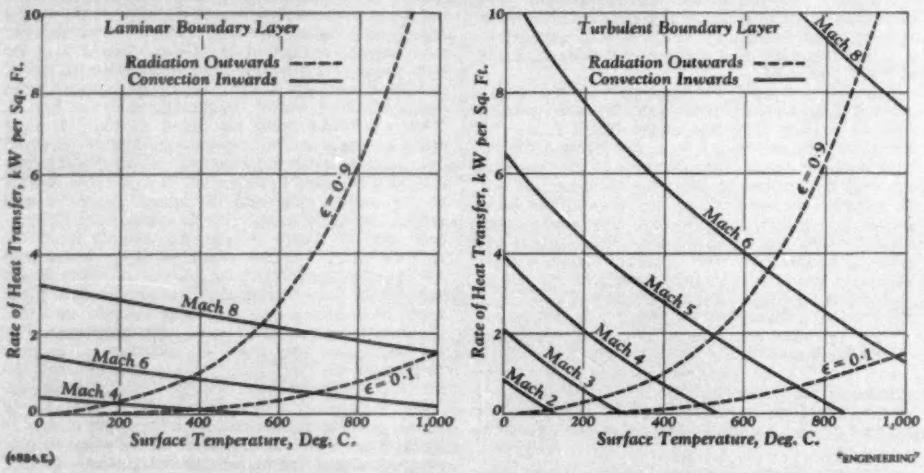


Fig. 5 (below) Local heat-transfer rates for flat plate under flight conditions. (Altitude, 75,000 ft.; Reynolds Number, 10^7). Skin temperature is determined by a balance between kinetic heating and radiation emission.

slender swept-back wings are well suited for flight at higher Mach numbers and present another natural solution just as unswept wings did for low speeds.

An interesting and exciting verification of the formation of the trailing vortex sheet can be obtained by a technique of photographing the smoke pattern formed when a dense stream of smoke is allowed to flow from a carefully chosen source upstream over the wing model mounted in a wind tunnel. Fig. 4 shows the vortex formation very clearly.

PENETRATING THE THERMAL THICKET

The " heat barrier " may be visualised as a region of flight speed, not with a definite limit at some particular speed, but with an increasingly severe influence opposing further penetration of the speed range above about Mach 2·5. The American popular term " thermal thicket " is perhaps a more appropriate one than " heat barrier."

An aircraft or missile in flight communicates energy to the air surrounding it. Part of this energy appears initially as motion of the air in the direction of flight and is subsequently dissipated as heat. Part appears directly as heat, especially in a thin layer—the boundary layer—surrounding the vehicle. A very rough rule is that the increase in air temperature at the surface is $(V/100)^2$ deg. C., where V is in m.p.h. The actual value, however, depends on the exact conditions of flow in the boundary layer.

The increase in temperature within the boundary layer leads to heating of the skin of the vehicle, known as kinetic heating. If there were no means by which the skin could lose heat, its " saturation temperature " would clearly be that of the air at the surface; at 1,500 m.p.h. for example this would be some 200 deg. C. above the ambient temperature. In fact the heating effect is relieved by re-radiation from the skin and also—for short durations as in missile flight—by the heat sink provided by the vehicle.

Fig. 5 shows typical heat transfer rates at various Mach numbers and illustrates a number of points: (1) The rate of heat transfer to the skin is very much lower if the boundary layer can be kept " laminar " instead of becoming " turbulent." This is an aerodynamic problem of the first magnitude on which research is continually in progress. (2) A laminar boundary layer ensures not only a lower rate of heating (thus enhancing the heat-sink effect of the vehicle) but also leads to a lower saturation temperature for a given surface emissivity ϵ. (3) The surface emissivity should be high. Thus, at Mach 5 an emissivity factor of 0·9 means that the surface will reach saturation at a temperature some 200 deg. to 400 deg. C. below that for no re-radiation, according to whether the boundary layer is turbulent or laminar respectively.

The significance of these effects in terms of structural design are obvious from Fig. 6, which shows the relative strength of light alloys, titanium and stainless steel over the temperature range. The realities are even worse than the illustrations suggest, since actual flight involves changes in speed and height which lead to rapid changes in skin temperature and cause structural stresses and distortions, coupled with complex patterns of heat-flow into and out of the main structure at the beginning and end of periods of flight at high speeds. To investigate these effects we need a combination of temperature and structural loading; experimental facilities of this kind for research on kinetic heating are described later.

HUMAN REACTIONS

During travel at high speed at a distance from the earth's surface the three basic physical conditions of normal life—environment, perceptual frame-work, and field of force—are all modified.

The changes are usually sufficient to make life impossible and some sort of artificial simulation of the normal earth-bound state is necessary.

Environment.—At ground level we live in an atmosphere of oxygen, nitrogen and water vapour at a total pressure of about 15 lb. per sq. in. and a temperature that lies normally within 30 deg. either side of 0 deg. C. Even at fairly low altitudes in the atmosphere these conditions change a great deal, and in outer space there is, in fact, no environment.

The first essential is to provide oxygen to breathe. During hard work, a man needs about 0·4 lb. per hour of oxygen, and he consumes this from a total quantity of gas which he breathes in and out of about 10 lb. per hour. This means that about 9½ lb. per hour of oxygen is wasted if 100 per cent. oxygen is supplied to the man. When he is resting, the figures are about 10 per cent. of these values.

The oxygen must be breathed at a partial pressure of between 100 and 150 mm., otherwise it cannot be absorbed in the lungs; thus, the air must be fed into the lungs under pressure when the body is exposed to high altitude. Since the lungs themselves cannot stand an internal pressure more than a few inches of water above the outside pressure, it is necessary also to provide a compensating external pressure on the chest. If this is done there is a tendency for the blood to be squeezed into the unpressurised parts of the body and, if life is to be sustained for more than a few minutes, the whole body must be pressurised.

Pressure suits are necessary at quite low altitudes in the atmosphere, from about 45,000 ft. upwards. Such suits must be just as flexible as possible, in order to avoid interfering with the man's normal physical activities, and they must be light and small and robust. The hinge points of the joints in the human body are all inside the body, so that it is difficult to design a mechanically-hinged device which can follow the body's movements; moreover, a flexible tube when inflated with pressure becomes rigid. Various schemes are being worked on to meet these difficulties but it will never be possible to make a pressure suit which will give the same degree of freedom of movement as will ordinary clothes.

The body can stand quite a wide range of temperature provided that there is sufficient water vapour to enable its own temperature-control system to work, but the transference of heat to and from the body is difficult with dry air because the temperature difference in the boundary layer which the body can comfortably stand is quite small. At the same time, large air velocities over the skin must be avoided. The body's consumption of water vapour is about the same as its consumption of oxygen, and a temperature difference across the boundary layer near the skin of more than 10 deg. C. is very uncomfortable. A further difficulty at great distances from the earth is the large increase in the effect of solar radiation leading to enormous apparent differences of temperature between the exposed and unexposed sides of a body.

Perceptual Frame-work.—The two main types of signal to which the human body reacts in controlling a vehicle are " vision " and " feel." The amount of information transmitted through " hearing " is not so important. At very high speeds, it is doubtful whether visual indications from the outside are of any value to a pilot at all, and it will be necessary to provide him with an artificial visual system in which the information will be carefully selected. There is very little knowledge of what are the important parts of the visual scene from the point of view of controlling a vehicle at very great speeds. In some circumstances it can even be argued that what you see directly with your eyes is positively misleading; at least it may well be frightening. On the question of feel, the criteria by which a system is judged are essentially subjective, and depend on all sorts of factors not amenable to measurements such as the degree of skill, psychological state, etc.

In general, it is very important in developing control systems to distinguish between the general decisions which the controller makes about what he wants the vehicle to do next and the more detailed considerations of how he maintains control during the course of any particular manoeuvre. The former is a problem of guidance or intelligence, the second one of engineering design.

Field of Force.—The human body is accustomed to living in a force field which gives an acceleration of 32 ft. per sec.^{2} towards the centre of the earth. As soon as very high speeds are achieved, or when travelling at great distances from the earth, this force field is considerably altered. At very high speeds small changes in direction lead to large changes in normal acceleration which can produce unconscious-

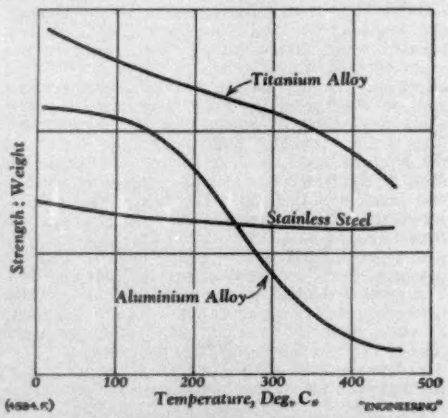


Fig. 6 Variation of metal strength with temperature. At temperatures corresponding to high speed, the alloys become seriously weakened.

ness and even death if maintained for any length of time. With the aid of a differential-pressure garment which increases the pressure over the lower half of the body, it is possible to survive accelerations up to 7*g* downwards for several minutes, but values higher than this can only be withstood for seconds or fractions of a second. Upward accelerations can be tolerated for even less time.

One of the difficulties in dealing with this problem is to carry out reasonably informative tests. Increases in the force field can be simulated on centrifuges and the like, but reductions to it, and in particular the case of zero accelerations, are extremely difficult to simulate in a realistic manner for any appreciable length of time. Nevertheless, experiments have been made by flying fast aircraft on parabolic paths at high altitudes to give weightless conditions for periods of 35 to 30 seconds and by firing monkeys up to great heights in rockets and observing them by recoverable instruments during the period of free fall. It appears that, at least for brief periods, no serious ill effects are produced, and pilots have reported that the sensation of weightlessness is quite pleasant, although manual co-ordination is somewhat impaired.

WIND TUNNELS

The furious tempo of development in aeronautical technology has demanded ever-growing experimental facilities. The final tests must always be made in full-scale flight, whether of aircraft or rocket, but the simulation of flight conditions in ground laboratories is of paramount importance.

Throughout the course of aeronautical history even before the time of the Wright brothers, the wind tunnel, in which a model is held in an artificial stream of air so that the forces on it and the nature of the airflow around it may be studied, has been a primary tool of aerodynamic research and development. It remains so to-day.

During the last 15 years of development, the wind tunnel has grown from a relatively simple piece of equipment, costing a few thousand pounds and absorbing a few hundred horse-power, into a major engineering complex, with a cost measured in millions of pounds, and absorbing up to 100,000 h.p. and more. A large supersonic tunnel requires extensive air-drying and cooling plant; the models to be tested have changed from carved wood to solid steel. The need to get a maximum output from such large investments has led to developments in measuring equipment, from simple balances and manometers to automatic recorders, with electric typewriters, automatic curve plotting, and machinery

Fig. 8 (left) A free-flight model mounted on its boost rocket. After the rocket has burnt, the model separates from its boost for the measurement phase.

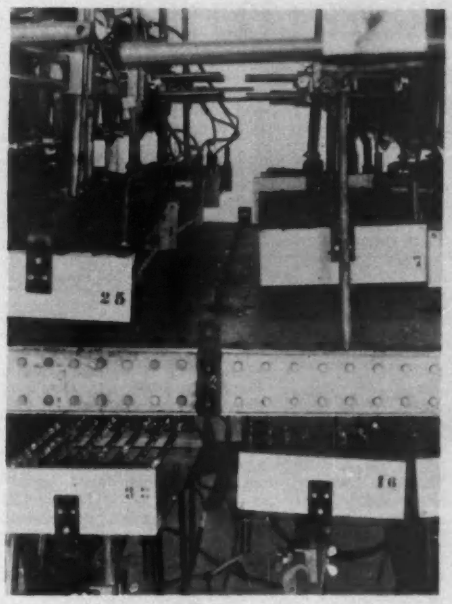


Fig. 7 A structure under test on a rig which simulates conditions of kinetic heat.

producing punched cards for feeding into electronic computers which produce the corrected data. This huge change in the scale of operations is brought about by the need to obtain dynamic similarity, so far as is practicable, between the wind-tunnel test and actual flight. To reproduce the effects of compressibility of the air, the Mach number of a test must be the same as in flight. For supersonic speeds this means that the tunnel must be provided with a specially-shaped and accurately-made covergent-divergent nozzle upstream of the working section, which will produce a uniform stream at the correct Mach number in the working section itself. A different shape of nozzle is required for each test Mach number; hence the tunnel must have either a number of interchangeable nozzle sections or a nozzle the shape of which can be varied by means of sliding parts or flexible walls. The manufacture of such an adjustable nozzle is in itself a major engineering undertaking.

To reproduce effects of viscosity, the Reynolds number should be the same in the wind tunnel as in flight. This means combining a large scale of model with high air pressure, and the ideal objective is rarely realisable. Fortunately, satisfactory results can be obtained with Reynolds numbers of the order of 1/10 the flight values, so that a compromise facility is possible, the financial and engineering problems of which are not insuperable. Such a compromise is obtained in the 8 ft. square supersonic tunnel of the R.A.E. Bedford laboratory,* which has a Mach number range from subsonic speeds to Mach 2·8.

The tunnel circuit is rectangular in plan form, on centre lines 350 ft. by 60 ft. The compressor, for driving the tunnel air, is a ten-stage axial machine with a 16½ ft. diameter rotor. For flexibility in operation the last six stages can be removed en bloc and replaced by a dummy section, leaving four stages for testing in the lower part of the speed range. The power requirement is up to 80,000 h.p. This is provided by a 68,000 h.p. alternating-current motor plus a 12,000 h.p. direct-current motor. The former can be supplied from special gas-turbine generators on the site, providing variable speed and freedom to run at all times. The cooler, installed in the maximum section, is of gigantic proportions and contains 55,000 tubes, each 16 ft. long. It is capable of removing the full 80,000 h.p., to be dissipated in the cooling towers.

The working section has a single flexible-walled nozzle capable of covering the full range of Mach number. The flexible walls (top and bottom) are steel plates 62 ft. long, 8 ft. wide and 1 in. thick, moved by a set of hydraulically operated jacks, with a control system which sets the profile to within 0·0025 in.

Auxiliary plant comprises compressor and evacuators for controlling the pressure of the tunnel air and dryers for maintaining extremely low humidity. The pressure control allows variation of the Reynolds number and of model loads. Maximum pressure is 4 atmospheres, minimum pressure one-tenth of an atmosphere absolute. Fully automatic recording and computing of data are provided. Much thought has been given to flow visualisation techniques and the model itself is under continuous observation by closed circuit television.

KINETIC HEATING RIGS

The problem of kinetic heating at high flight speeds, coupled with the fearful penalties of miscalculation of structural strength, point to the need for equipment to allow extensive ground experiments. Complex structures must be tested under thermal and loading conditions as near as possible to those expected in flight. For simple joints an oven can be added to a standard testing machine. For tests in which variation of the heat applied is necessary, or in which the temperatures are not uniform over the whole structure, it is possible to use radiant heating applied locally over the surfaces of the test specimens at different intensities. Twenty-four infra-red lamps, each absorbing 3 kW when operating at 440 volts, are mounted in front of a reflector in a unit 14 in. long by 8 in. wide. The maximum intensity from such a unit is about 130 kW per sq. ft., and, with the surface of the test structure well blacked, about 60 kW per sq. ft. of this can be absorbed with the heater 3 in. from the surface. These heat loadings are higher than necessary for holding steady temperatures, and usually groups of two or four units of eight lamps running at 110 volts are used, each group being controlled by a thermostat to simulate the required heating distribution over the surface. Fig. 7 illustrates such ovens in place adjacent to a specimen; by leaving gaps between the ovens of about 2 in. there is room for the individual loading links of a standard multi-lever loading system to be brought down to the specimen through the oven assembly. The individual ovens are arranged to be held at a fixed distance from the surface, moving with the structure as it deflects.

During transient-heating tests, the ovens must be controlled individually or in small groups, in order to simulate correctly the changing heat inputs over the surface of the aeroplane. From the assumed flight pattern, aerodynamic-heating functions are

Fig. 9 (right) Control room of TRIDAC. The R.A.E. flight simulator, an electronic calculating machine among the biggest in the world.

* ENGINEERING, vol. 184, page 52, July 12, 1957.

calculated before the test starts; as the test proceeds, surface temperature is measured under each oven and is fed back into a computer which—from a knowledge of the flight programme and the aerodynamic functions—continuously adjusts the voltage on the oven to give the requisite heat flow. Since very large numbers of ovens must be controlled individually when dealing with a big structure, a formidable mass of computers and controllers is involved, and there is scope for much ingenuity in cutting down the cost and size of the whole scheme by time-sharing devices whereby one computer deals in rapid succession with a number of heat controllers. Testing large specimens, however, must involve complex apparatus; the kinetic-heating structural test frame is an essential complement to the large supersonic wind tunnel.

FREE-FLIGHT ROCKET MODELS

In Britain the beginning of the use of freely flying models to study the laws of flight can be said to date from the middle of the Eighteenth Century, when Benjamin Robins in 1746 reported to the Royal Society experiments he had made on the variation of air resistance with velocity by firing projectiles of known weight and velocity against a ballistic pendulum which he himself had invented. When we recall that he observed the failure to obey a V^2 law above 1,100 ft. per second and remarked on the possibility of this having some connection with the speed of sound, we may well feel that this early experimenter was much before his time.

The pioneering use in the United Kingdom of small ground-launched rocket models to explore aerodynamic behaviour at supersonic speeds was by the guided weapon team at Farnborough and it was quickly taken up by aerodynamic workers. Solid-fuel rockets are used, and they may either be integral with the model or may separate at "all-burnt," leaving the model coasting on during the measurement phase. Velocities are obtained from the usual Doppler technique or from kinetheodolites, while pressures, forces, and so on are measured internally and transferred to the ground by telemetry. Fig. 8 indicates such a model mounted pick-a-back on its boost.

The technique lends itself well to a study of overall stability and control, by exciting and studying the short-period oscillation—longitudinal or directional—induced by movement of a control surface or by small lateral jets. Drag at zero lift is also readily studied. Measurement of drag at high lift is more difficult, making much larger demands on accelerometer technique. Pressure measurements are regularly taken, during base-drag and intake work. Valuable information on heat transfer can be obtained from thermocouples spot-welded to the inside of a thin-walled outer shell. The technique regularly covers Mach numbers of from 0·8 to 5·0, and the upper Mach number can fairly readily be increased.

Quite apart from purely aerodynamic work, free-flight models are also extensively used for flutter and aero-elastic investigations.

SIMULATORS

A new research tool for the investigation of missile and aircraft flight has come into increasing prominence during the last five to ten years, the electronic simulator. Although basically a calculating machine, its circuits and mechanisms can be set up to represent a synthetic working model of either parts or the whole of a complex missile or aircraft system. Voltages can be made to vary like flight speeds and accelerations, to represent aerodynamic lift or drag and complicated relationships between flight manoeuvres in different planes, or to simulate the missile-guidance electronics or control servo-mechanisms. By this means the most complicated dynamic effects in aircraft flight or the behaviour of guided missiles flying in air or outer space can be represented and studied before actual construction and test begins, in order to determine the most suitable values for the multitude of design parameters which govern the overall layout and the performance of the complex aerodynamic or jet controls, servo-mechanisms and electronic devices which form the muscles and nerve centre of modern supersonic missiles and aircraft. A typical simulator of this kind is TRIDAC (three-dimensional analogue computer) at R.A.E., Farnborough.

TRIDAC is the biggest calculating machine in the United Kingdom, and among the biggest in the world. A view of the control room is given in Fig. 9. It occupies 6,000 sq. ft. of floor space, uses 8,000 valves, and under peak conditions absorbs about 650 kilowatts from the supply mains. TRIDAC has been built on analogue rather than digital principles for the following reason. Digital machines can be programmed to carry out long series of operations in sequence, with great accuracy. However, with existing techniques, large numbers of operations cannot be carried out simultaneously (or sufficiently quickly when executed in sequence) so that in general an involved problem cannot be reproduced on a real time scale and thus the inclusion of parts of the real system in place of the machine calculation is not possible. It may be that, in the future, digital machines will operate more rapidly so that the construction of real time-scale simulators of high inherent accuracy will be possible. At present, exclusive of consideration of the time taken for setting-up, programming, etc., certain problems which might be solved on a digital machine would take several hundred times longer in actual machine computation time than the same problems on TRIDAC.

Since TRIDAC works in the same time scale as the real system, actual pieces of "hardware," such as the actuator which moves the control surfaces in a guided weapon, can be included in the operation of the computer. A voltage in TRIDAC which represents the input signal to the missile control system is brought out and fed into the actuator which may move either a real control surface or a dummy. The control surface carries a potentiometer which provides a voltage proportional to the angle through which it turns, and this voltage is passed back into the computer for the calculation of rate of roll, etc. This procedure allows measurements to be made of the effect of using different kinds of actuators. Aeroplane systems can be simulated in the same way, and the pilot can be included when required. He can be provided with displays of radar and instrument formation, operated by signal voltages from TRIDAC, and he operates controls of the aircraft type.

To be continued

Design

DE-SALTING BRACKISH WATER FOR DRINKING

The development of countries which are at present hampered by possessing brackish water supplies will depend to a very large extent upon the successful solution to the problem of providing them with usable waters at an economic cost.

A new plant shortly to be installed in the town of Tobruk for the Libyan Public Development and Stabilisation Agency, for the de-salting of brackish water, was demonstrated recently in the works of the makers, William Boby and Company, Limited, Rickmansworth, Hertfordshire. The plant has been developed as a result of the collaboration of Messrs. Boby, the Department of Scientific and Industrial Research and the Central Technical Institute T.N.O., Holland, originally under the auspices of O.E.E.C., and latterly of U.N.E.S.C.O.

The object of the plant is to produce at an economic price a potable water for domestic and agricultural purposes from brackish water having a high salt content. Hitherto all processes with this object have depended upon evaporation and distillation, which are costly. It appears that even the use of solar heat proves very expensive in capital and maintenance costs.

The principle employed in the new plant is known as the electrodialytic membrane de-salting process and, in this, the brackish water flows through a cell formed from two ion-permeable membranes. One of the membranes is permeable to positive and the other to negative ions. A small electric current is passed through the cell between two electrodes situated outside it, and rinsing water flows in the electrode compartments. The Na, Cl, and other ions forming the salinity are attracted towards the electrodes according to their electrical charge, and the effect is that the ions in the water passing through the cell move

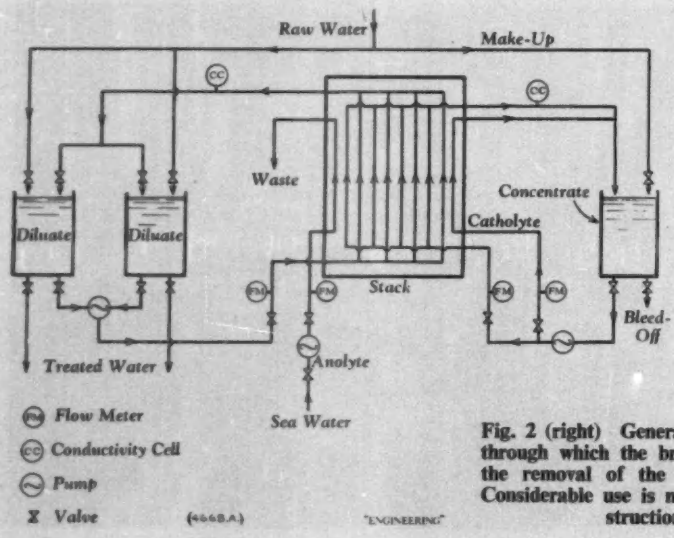


Fig. 1 (left) Flow diagram of the plant to be used for de-salting well water at Tobruk, Libya. The raw brackish water is treated by a process in which the water flows through a cell or "stack" formed from positive and negative ion-permeable membranes.

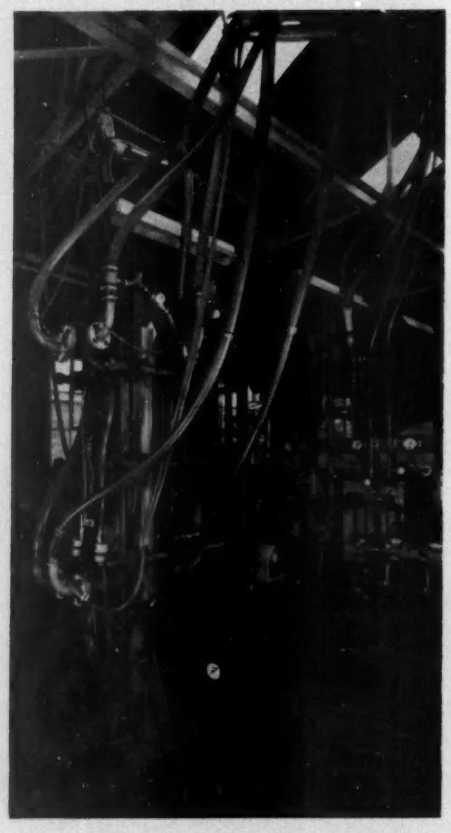


Fig. 2 (right) General view of the cell or stack through which the brackish water circulates for the removal of the ions forming the salinity. Considerable use is made of plastics in the construction of the plant.

out of the raw water through the membranes into the rinse water flowing through the electrode compartments. Sea water is used for rinsing out the Cl ions, and raw-water concentrate (acidified with hydrochloric acid so as to convert hydroxide salts into chlorides) is used for rinsing out the cathode compartment. The rinsing water is discarded. The water leaving the cell is de-salted but the process of de-salting is not complete without re-circulating the water. The recirculation, however, is stopped short at a point at which there is still some salinity left in the water, but the amount, about 500 parts per million, is so small that the water is tasteless and potable in all respects. The raw brackish well water at Tobruk contains 4,600 parts per million of total dissolved solids.

A flow diagram of the plant is shown in Fig. 1 (page 468) and a general view of the cell, or stack as it is termed, is seen in Fig. 2. On the right may be discerned the two open lids of the tanks containing diluate, as the water in process of de-salting and re-circulation is called. One of the pumps is also seen close to the floor. In the stack and towards the left of it are seen the long rectangular membranes, the positive and negative types being arranged alternately. It will be noted that all the connecting pipes are of polyvinyl chloride and all other pipes, valves and tankwork of the plant are either made of, or protected by, plastics material and are therefore free from corrosion. The pumps can also be plastics covered or made of non-ferrous metal and stainless-steel components. The maximum economic output of the present plant is 40 tons of treated water a day, based on the use of 200 membranes. When the plant is dismantled and re-assembled in Tobruk we understand that 500 membranes will be used. This more than doubles the output, which will be at the rate of 1,000 gallons an hour (or, say, 100 tons per 24 hours) and the estimated cost will be approximately 5*s*. per 1,000 gallons of water produced. Batchwise operation has been adopted as being more efficient than continuous working; it is pointed out, moreover, that the former method of operation has few disadvantages and that it can be made automatic quite readily. The plant is suitable for operation by local labour and a staff of two men is required. Water-filtration and pre-softening plant has been provided should this be needed but, so far, it has not been found necessary.

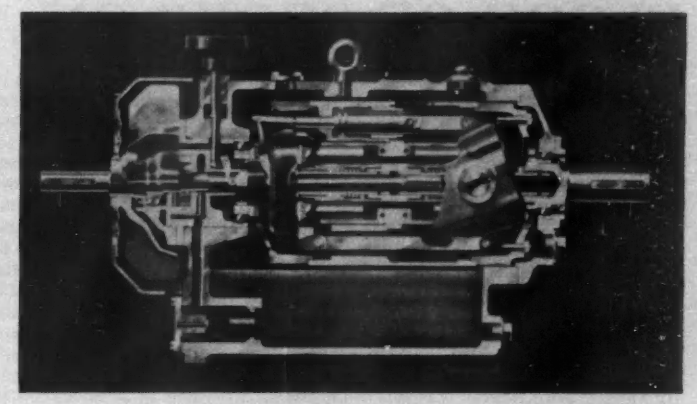
The membranes used in the present plant were manufactured in the Netherlands under laboratory conditions. They are produced from a powdered ion-exchange resin mixed with powdered polythene and sintered together at a low temperature. The final process is to calender the product into sheet form. It is stated that the same type of membrane could be made in England under commercial production conditions. The estimated membrane-replacement costs represent 1*s*. 6*d*. or 2*s*. per 1,000 gallons of water de-salted. This figure is based on a membrane cost of 2*s*. per sq. ft., and a life of 18 months. Damaged membranes can be repaired without loss of efficiency.

The electrodialytic de-salting process, it is claimed, is nearly 100 per cent. electrically efficient, the direct current consumed can vary from 7 to 25 kWh per 1,000 gallons according to the rate at which the water is de-salted. The alternating current required, on the other hand, is constant and need not exceed 2 kWh per 1,000 gallons of water treated. We are also informed that from 65 to 80 per cent. of the total brackish-water output from a well can be procured as de-salted water according to the de-salting rate and the efficiency adopted.

The process will work efficiently over almost any range of total dissolved solids in the water, but it is emphasised that it is unlikely to be economic outside the limits of 10,000 parts per million de-salted down to 500 parts per million. The 5,000 parts per million contained in the Tobruk well water is a good deal less than is found in sea water, but is nevertheless representative of a large portion of the world's natural water supplies.

STEPLESS SPEED REDUCER

The Varicon speed reducer developed by the David Brown Corporation Sales Limited, Radicon Division, Park Works, Huddersfield, offers a range of speed from a 1 to 1 ratio down to zero on the output shaft. The size 5 that was exhibited at the recent Engineering Exhibition at Olympia transmits up to 5 h.p. It incorporates a hydraulic pump and hydraulic motor, both of the positive-displacement type, located in line and with their cylinder heads separated by a central distributor plate which transfers oil from pump to motor and also takes the reaction of the oil pressure on the pistons. Both pump and motor have the piston displacement controlled by swash-plates which can be adjusted through a linkage by an external hand-wheel. The angular setting of the plates governs the ratio transmitted. A servo cylinder and coupling rod, both of which are carried in the output shaft frame, assist in changing the swash-plate angle. The oil required for the servo-cylinder operation is supplied by the main pressure pump.



As shown, the Varicon is transmitting at 1 to 1 speed ratio. By varying the swash-plate angles, the output speed can be reduced to zero.

The position of the swash-plates in the diagram is for a 1 to 1 ratio. The pump pistons are set to give maximum stroke and the motor pistons for zero stroke. Under these conditions a hydraulic lock exists. In intermediate ratios both swash-plates are inclined, and the output shaft speed is reduced to zero when the motor swash-plate reaches its maximum inclination and the pump swash-plate has none. A small loss in speed does occur, not exceeding 1 per cent. of the input speed under any condition. For intermediate ratios, the drive is partly hydraulic and partly mechanical, as both sets of pistons reciprocate, whereas in the 1 to 1 ratio, the drive is wholly mechanical, due to the hydraulic lock that exists. Oil is supplied from a primary pump driven from the input shaft and is circulated from the sump through the shaft sleeve to the cylinder bodies. A magnetic oil filter is fitted as standard. The torque transmitted by the unit varies slightly over the output speed range from approximately 210 lb.-in. at 500 r.p.m. to 220 lb.-in. at 1,200 r.p.m., which figure corresponds to an input of 5 h.p.

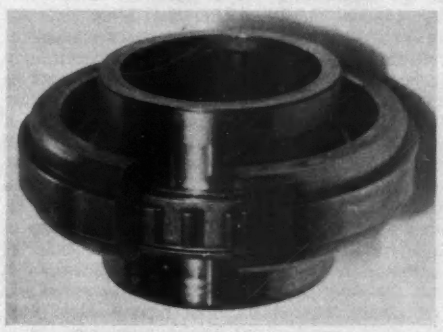


Fig. 1 One-way clutch showing the driving sprags.

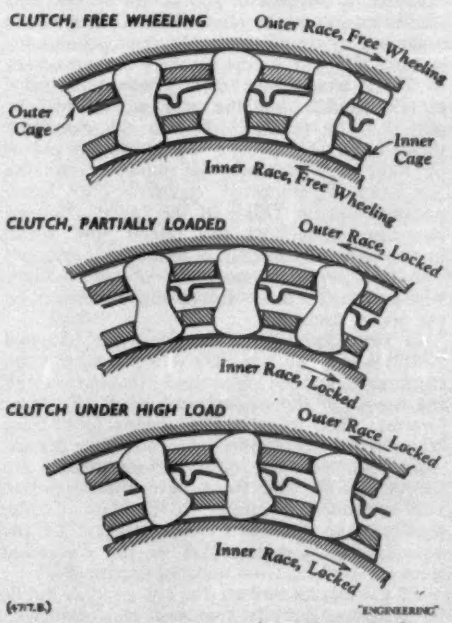


Fig. 2 Sprag position under different loads.

★ ★ ★

ONE-WAY CLUTCH

Borg-Warner Limited, Letchworth, Herts, have developed a one-way clutch being manufactured at present in three standard sizes, the largest of which will transmit a torque of 773 lb.-ft. It consists of a number of small cams or sprags made of ball-bearing steel (E.N.31), hardened to Rockwell C 62 to 65, which bear between an inner and outer race to transmit the drive. The sprags are held in two circular cages by means of a stainless-steel ribbon spring. The operation of the sprags is shown in Fig. 2.

A feature of the design is the use of two flanged cages which ensures that the sprags are fully phased so that they work in unison, distributing the load equally among them. These cages are made from SAE 1045 hardened and tempered to Rockwell C 32 to 37.

The three sizes at present manufactured as standard, have capacities of 354, 525 and 773 lb.-ft., but it is planned to extend this range as required. The corresponding diameters for the inner race are approximately 2·16 in. for the smallest, and 2·27 in. for both the larger sizes. Clutches have been made having torque capacities from 103 lb.-ft. to 4,060 lb.-ft.

★ ★ ★

ELECTRIC SIREN

An improved version of the smallest model of their electrically-driven general-purpose sirens, is now being put on the market by the Service Electric Company, Limited, Secomak Works, Honeypot-lane, Stanmore, Middlesex. Weighing only 3 lb. and measuring 8 in. by 4 in. by 4 in., it can be fitted in most situations outdoors or indoors. A universal motor drives it, and a note of nearly 1,000 cycles per second is generated.

Book Reviews

FLOOD OF BOOKS ON AUTOMATION: A GUIDE

By J. F. Coales, O.B.E., M.A., M.I.E.E., F.Inst.P., Engineering Department, Cambridge University

During the past few years a large number of books have been published on automation. If we exclude the text-books on servomechanisms and automatic control, most of the books on automation have been intended for the general reader. There have, however, been a few books published recently, intended for engineers responsible for the introduction of automatic lines and computer installations in industry.

Mention should first be made of the only known text-book on the design of automatic machines,[1] published in Moscow in 1955 and available in a German translation published by Vebverlag Technik of Berlin in 1956. This book only deals with the mechanical design of automatic machines for various purposes but it is very comprehensive and has an interesting bibliography of work published in Russia up to 1954. The only other text-book dealing directly with the design of automatic systems is *System Engineering*, by Goode and Machol,[2] which collects together a large number of techniques that have to be used in system design but which, until its publication, had not been collected into one place. This should be of great value to systems designers and it has a very fine bibliography of 145 entries. On the office automation side *Electronic Data Processing for Business and Industry*, by R. G. Canning,[3] gives a clear presentation of the principles underlying the design of a data processing system and tells the systems engineer how to set about the investigations, collection of data, and calculations required to design the most suitable system. The author gives some good examples of actual data processing systems and then describes the chief components which go to make a complete one. Although the author says that his book is primarily intended for management, it is the best exposition of systems engineering, in the field of data processing, which has yet appeared and so engineers concerned with the design or operation of such systems will have much to learn from it.

Other books primarily intended for the engineer are *Principles of Mass and Flow Production*, by F. G. Woollard,[4] and *The Automatic Factory, What Does it Mean?*[5] which was the report published by the Institution of Production Engineers of their conference at Margate in 1955. Mr. F. G. Woollard is well-known as the chief engineer of Morris Motors who introduced the first transfer machine into Britain in 1924, and naturally he speaks with authority. All engineers concerned with the introduction of automatic lines should read this book because he sets down 18 basic principles for flow production, all equally applicable to automatic production, and then discusses, one by one, how they may be satisfied. In addition it is a fine historical record of automatic production up to 1950. The papers presented at the conference deal not only with the engineering aspects but also with the impact of automation on trade unions, management and other social problems; but the majority of the papers deal with engineering aspects and are intended for the engineer. A. J. Young's *An Introduction to Process Control System Design*[6] should also be mentioned since although it is only concerned with the chemical and allied industries, this is one of the most important fields of automation and it is an excellent starting point for the young control engineer. The book is written with the authority of experience.

The most recently published book *Automation in Business and Industry*[7] is a veritable vademecum covering both theory and practice. Edited by E. M. Grabbe of the Raino-Wooldridge Corporation it consists of 600 pages of text divided into nineteen chapters covering the theory of automatic control, analogue computers, digital computers, data processing, automatic control of flight, process control, digital control of machine tools, manufacturing automation and other topics, each written by an expert well known in the United States. It contains a vast amount of information and each chapter has a useful bibliography. It is not a book to be read from cover to cover, except by the enthusiast; but as a book to be referred to when a particular problem arises it should be extremely useful for several years to come. It appears to be both comprehensive and up to date, and although expensive—80*s*. in this country—is undoubtedly very good value.

Of the more general books on automation, the first to be published was written by John Diebold[8] in America in 1952, as the result of an investigation carried out at the Harvard Business School and is an excellent account of what had been done in America up to 1950, what were likely to be the future developments and what would be their social and economic effects. Mr. Diebold is not an engineer but he evidently has a good appreciation of engineering considerations and, although his is the first book on the subject, it is still worth reading.

Norbert Wiener's *Cybernetics*[9] cannot be considered to be a book directly concerned with automation but his *Human Use of Human Beings*[10] is probably the first book in which the human problems are discussed. It is a very readable book but cannot be considered to be authoritative, since at the time it was written very few, if any, case studies had been carried out.

As is well known, United States Congress set up a sub-committee to consider the effect of automation and technological change on economic stability, which heard the views of many industrialists, trade union leaders, economists and Government experts on the economic and social implications. The report of these hearings[11] was published by the United States Printing Office in 1955 and contains excellent information on the status of automation in a large variety of American industries as well as the outspoken views of those who gave evidence. The only official British publication is that of the Department of Scientific and Industrial Research,[12] which is, as its sub-title proclaims, a concise report on the technical trends and their impact on management and labour as they appeared in 1956. It has a bibliography of 207 entries, ranging over the whole field of automation and of all relevant nationalities. It has the great merit of being well illustrated and yet cheap. Other national reports have been prepared, notably by France, Belgium, West Germany and Sweden, but these are not yet available to the general public, nor are the case studies presented to an O.E.E.C. Conference organised by the European Productivity Agency in April this year, except for the three carried out by P.E.P. which have recently been published.[13] It is probable that the case studies will be published by O.E.E.C., but in the meantime those interested can no doubt obtain copies of these and the national reports from the European Productivity Agency. The International Labour Office of the United Nations has also considered the labour and social implications of automation and atomic energy[14] and has published a report of its findings, which contains much interesting discussion on the social problems.

In December, 1955, the Society of Applied Anthropology at Yale University held a small conference entitled *Man and Automation* and the report of the conference[15] is of very great interest, since informal discussions took place between representatives of university departments, Government offices, management and labour unions and these have been reported with considerable skill. A number of case studies were discussed and members of the various panels taking part in the discussion were all speaking from personal experience.

Of the books written for the general public by individual authors, that most concerned with the social effect is *What Automation Does to Human Beings*,[16] by George Soule. This is a particularly interesting and reassuring book, since the author shows how Karl Marx's predictions have proved almost completely wrong as applied to the American economy, while those of John Stuart Mill were very much more accurate. This is mainly because John Stuart Mill took a much more optimistic view than Karl Marx and looked forward to a State "where there could be a better distribution of income and a much larger body of persons than at present, not only exempt from the coarser toils but with sufficient leisure, both physically and mentally, from mechanical details, to cultivate freely the graces of life." Mr. Soule says that in America, with increased leisure and an increased standard of living, all classes of society are taking the opportunity to indulge in hobbies of a creative tendency, as is exemplified by the "Do It Yourself" craze. He discusses how in the end there must be a limit to the quantity of goods and services a man can employ, since even when the hours of enforced work are reduced to a minimum, the amount of time available outside eating and sleeping is limited. Thus, in the end, a static economy must result, but there is much to be done in improving housing conditions and use of leisure before this state is reached. Mr. Soule goes on to say that there is no need to fear such a static state. It is those who believe, with the reactionaries, that man must work in order to be kept out of mischief, who fear this state, and the challenge is for us in the absence of the "discipline of a boss" to learn to discipline ourselves. Mr. Soule believes that, if work of one kind is no longer necessary, an opportunity arises to find work at something more worth while and the evidence is that in America men and women are doing just this. The interest of this book is greatly enhanced by copious quotations from the Nineteenth Century economists.

Coming to books which include popular accounts of the technical aspects of automation, the little book *Automation—Friend or Foe?*, by R. H. Macmillan[17] has the great merit of extreme clarity while being quite short, less than 30,000 words in length. In order to explain the basic principles of automatic control, the author uses simple and well-known examples such as the domestic thermostat, and this, combined with the excellent format of the C.U.P., has resulted in a book that should have a wide appeal.

Three other books intended for the general reader, which all appeared at about the same time, are *Automation—its Purpose and Future*, by Magnus Pyke[18], *Automation and Social Progress*, by S. Lilley,[19] and *Automation in Theory and Practice*," edited by E. M. Hugh-Jones.[20] Each of them has its good points but each also demonstrates that when a writer strays from his own subject he is likely to be inaccurate both in subject matter and in implications. In this respect, Mr. Pyke is the worst offender, and Dr. Lilley the least. Of the course of lectures given at Oxford and edited by E. M. Hugh-Jones, the experts are above suspicion, but the later more general lectures are misleading in some respects. Technically, Dr. Lilley's book is by far the best and most comprehensive that has yet been written for the ordinary reader. His history of automation is excellent, particularly of what has been done in Russia, and his discussion of what is likely to happen in the future and of the requirements to make automation effective in Britain are supported by well-documented information and his conclusions are far-seeing and important. It is therefore most unfortunate

that, when he deals with economic and political matters, what he says is highly coloured by his political views.

Mr. Pyke is a chemist and does not claim to be an expert on automation; as a result, the early part of his book, in which he discusses automation as applied to mechanical engineering, is full of errors. But when he comes to automatic chemistry and the petroleum industry, his description of what has been done is excellent. He goes on to describe the application of automation in fields other than manufacture, such as accounting, transport, food and catering, the distributive trades, guided weapons and automatic translation. As far as is known, this is the first time that this information has been gathered together in a single book.

By far the most impressive of the lectures at Oxford is that of Mr. Nicholas on the trade union approach to automation. The approach of trade union officials is almost always sensible and realistic and that of Mr. Nicholas is no exception. His lecture is a model of reasoned exposition based on sound premises; he points to many failings, both in our planning and in industry, and suggests ways of correcting them. What he says we expect of automation will be agreed by all, whatever their political views, and is worth quoting. "If we want higher wages, shorter hours, better education, improved pension schemes, we have to be able to afford them. Automation provides one way to assist in achieving these things. It is by no means a complete answer but, in as much as it can have a profound effect on our future well-being, we must welcome it and not fear it, we must control it and not let it submerge us, and its advantages and benefits must be enjoyed by the many and not utilised for the privilege of the few."

The book on automation most recently published in this country is a Pelican, *Man and Automation*, by L. Landon Goodman,[21] and for the general reader this is very good indeed. The first part gives a brief historical account of the development of automation and a useful review of the present state of the art in industry and commerce; it is adequate to give the reader a picture of what automation means technically but is not as good an account as that of Dr. Lilley. However, the second part, without doubt the more important, shows a remarkable insight into social problems and those of management. Like most engineers he is optimistic concerning the improvement of working conditions that will result from widespread automation but not unduly so, and he does not underestimate the importance of dispelling the fear of change that most people have, particularly those who have known unemployment. He quotes Descartes—"Good sense is, of all things among men, the most equally distributed"—and goes on to say, "clear explanations, a proper display of consideration and courtesy, can do much to bring reason to bear. It is often a long, tedious, and exasperating process, for most men at times can hear only what they wish to hear, and it is always a little more exhausting talking to a deaf person." This must be taken to heart by all concerned with the introduction of new ideas, since, as Mr. Goodman says, it is the only way to minimise resistance to technical change so that the process may be speeded up for the good of the nation. This is a purely materialistic argument and quoting W. P. Reuther, president of the C.I.O. in the United States, he says, "The true argument is that 'the real measurement of the worth of any free society is the ability of that free society to translate technical progress into human progress, into human happiness, into human dignity' for the individual. A happy individual is a gain for society; an unhappy individual a loss for society. The reader is, of course, free to accept whichever argument appeals to him, but let us hope that he agrees that change must be maximised and disturbance to the individual minimised by planning (by management, unions, and Government), and by education."

On the Shelf

By Frank H. Smith

Aslib announce that a conference will be held, bearing the title "Library Services in Technical Colleges." It will take place on October 30 at the Connaught Rooms, Great Queen-street, London, W.C.2, and the cost is 30*s*., including lunch. The morning session, at 10 o'clock, will have as its chairman, Alderman J. W. Brown, who is chairman of the London and Home Counties Regional Advisory Council for Higher Technological Education, and Sir Edward Boyle will give the opening address. The Earl of Verulam will speak on "Libraries: A liberal element in technical education," and Mr. S. T. Broad, Education Officer for Hertfordshire, on "A Technical Library Service." In the afternoon, at 2 o'clock, Sir Wavell Wakefield will take the chair, and Dr. J. Topping, Principal, Acton Technical College, will speak on "The Technical College Library as an Educational Instrument," and Mr. P. P. Love, Director of Research and Development, Glacier Metal Company, Limited, on "Co-operation with Local Industry."

If it be remarked that librarians do not seem to figure very largely in this programme I would add that in an accompanying note Aslib say "It will be seen from this programme that the conference is intended primarily for principals of technical colleges, officers of local-education authorities and technical directors . . . of industrial concerns. It is obvious, however, that the librarians of technical colleges and firms have a useful contribution to make *to the discussion* (my italics) and fifty places, to be allocated in order of application, are being reserved for librarians in these categories." From up here, on the shelf, I can look down on this last sentence and see it as a very gracious concession. We librarians are, of course, only too conscious that we are the least able executants of our own jobs. We are always ready to learn and, what is more, others are always ready to teach us. On the other hand, when we *do* speak it is usually to each other. That's why people don't realise our true worth.

I notice that the Library Association received quite a good Press for its annual meeting. One speaker was trying to find out what is to be done regarding the "floating" nature of the profession. He was, of course, referring to public libraries. It is an extraordinary thing that your average man (or woman) who would nowadays shrink from the idea of working on a Saturday morning expects such services as libraries (and banks and shops, of course) to stay open not only Saturday morning but afternoon and evening as well. In addition to this, the library is to be available every other night of the week until eight or nine o'clock. And they wonder why library juniors come and go and library seniors look for commercial libraries.

A draft British Standard that may have an even wider interest than usual has been circulated for comment. It is Draft British Standard "Notes on Presentation for Editors of Periodicals." This will be a revision of B.S. 2509: 1954 (Layout of Periodicals) and if anybody has strong views on layout he should get hold of a copy of this from the British Standards Institution, 2 Park-street, London, W.1, in time to submit any suggestions by October 31.

Autumn is upon us and those symbols of the season, the bulb price lists and publishers' catalogues come thick (in bulk and number) and fast. The list of Oxford University Press contains their usual selection of such subjects as archaeology, economics, history, mathematics, physics and chemistry. A loose leaf announces the publication of *Selected Speeches* 1948-1955: *H.R.H. The Prince Philip, Duke of Edinburgh*. At 12*s*. 6*d*. this volume, I imagine, will be in demand.

The American Society of Mechanical Engineers, in *Mechanical Engineering*, have produced another of their useful surveys of a year's literature in the September issue. "Bearings, Lubricants and Lubrication: A Digest of 1956 Literature" is the title and the bibliography which the digest covers runs to 163 references and books.

The four houses of Springer Verlag (in Berlin, Göttingen, Heidelberg and Vienna) have produced their combined catalogue, covering 1945 to March of this year. Including subject and author indexes, it has 256 pages and is available from Lange and Springer, Reichpietschufer 20, Berlin W.35, Germany.

Hydraulic Research in the United States, 1957, is the title of Miscellaneous Publication 221 of the United States National Bureau of Standards, and obtainable from H.M. Stationery Office at an equivalent of 1·50 dols. Edited by Helen K. Middleton, it lists the research and other work of various hydraulic and hydrologic laboratories in the United States and Canada. It is a guide (but not a detailed report) and as such indicates only the type of research that goes on at any particular laboratory, but a reader who finds a subject in which he is interested can obtain details from the source. A subject index ranges from accelerated motion to wind tides.

BIBLIOGRAPHY

[1] Schaumjan, G. A., *Automaten*. Vebverlak Technik, Berlin (1956).

[2] Goode, Harry H. and Machol, Robert E., *System Engineering*. McGraw-Hill Book Co. Inc., New York, Toronto and London (1957).

[3] Canning, Richard G., *Electronic Data Processing for Business and Industry*. John Wiley & Sons Inc., New York; Chapman & Hall Ltd., London (1956).

[4] Woollard, Frank G., *Principles of Mass and Flow Production*. Iliffe & Sons Ltd., London (1954).

[5] Report of Conference held at Margate, June 16-19 (1955), "The Automatic Factory—What Does It Mean?" Institution of Production Engineers, London.

[6] Young, A. J., *An Introduction to Process Control System Design*. Longmans, Green & Co., London (1955).

[7] Grabbe, E. M., *Automation in Business and Industry*. John Wiley, New York; Chapman & Hall, London (1957).

[8] Diebold, John, *Automation*. MacMillan & Co., Ltd., London (1952).

[9] Wiener, Norbert, *Cybernetics*. Massachusetts Institute of Technology (1948); Chapman and Hall, London (1949).

[10] Wiener, Norbert, *The Human Use of Human Beings*. Houghton Miffin Co., Boston, Mass. (1950); Eyre, England (1955).

[11] "Automation and Technological Change," hearings before the sub-committee on Economic Stabilisation of the Joint Committee on the Economic Report, Congress of the United States, U.S. Government Printing Office, Washington (1955).

[12] *Automation*. Dept. Sci. Ind. Research. H.M.S.O., London (1956).

[13] *Three Case Studies in Automation*. Political & Economic Planning, London (1957).

[14] Report of the Director-General, Part I, "Automation and Other Technological Developments." International Labour Conference, I.L.O., Geneva (1957).

[15] "Man and Automation." Report of the Proceedings of a Conference sponsored by the Society for Applied Anthropology at Yale University, Dec. 27, 28 (1955). The Technology Project, Yale University, New Haven, Conn. (1956).

[16] Soule, George, *What Automation Does to Human Beings*. Sidgwick & Jackson, London (1956).

[17] Macmillan, R. H., *Automation—Friend or Foe?* University Press, Cambridge (1956).

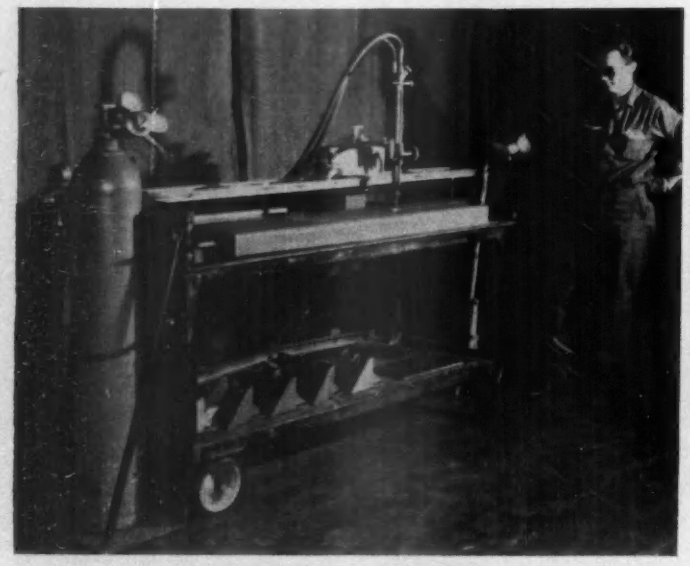
[18] Pyke, Magnus, *Automation: Its Purpose and Future*. Hutchinson's Scientific and Technical Publications, London (1956).

[19] Lilley, S., *Automation and Social Progress*. Lawrence & Wishart, London (1957).

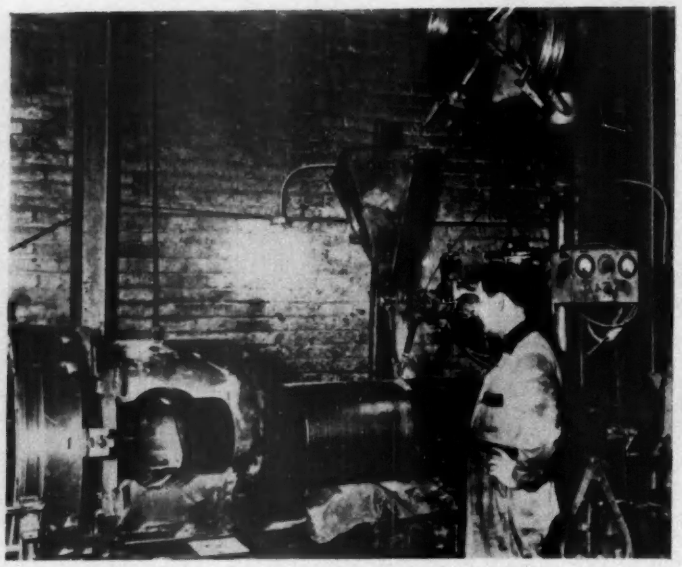
[20] Hugh-Jones, E. M., *Automation in Theory and Practice*. A course of Lectures organised in Oxford in 1955. Basil Blackwell, Oxford (1956).

[21] Goodman, L. Landon, *Man and Automation*. Pelican Books (1957).

Production



A Linde oxygen cutting machine, mounted on a simple fabricated table, made by the user, provides mobile gas-cutting facilities for short-run production or maintenance work.



An ordinary centre lathe is easily adapted for continuous deposition of weld metal on cylindrical components by submerged-arc welding. This provides a method by which worn parts can be easily repaired.

FASTER WORK IN THE FABRICATING DEPARTMENT

It is not always necessary to employ complicated and expensive machinery to speed up production. Often some simple device can help considerably and existing machines can be modified, or new equipment made, at low cost. Three such simple methods of speeding up production, one purchased and the other two capable of being carried out in the average engineering shop, have been announced by the Linde Department, Union Carbide International Company, Division of Union Carbide and Carbon Corporation, 30 East 42nd-street, New York 17, N.Y., U.S.A.

Much time can be lost through spatter pick-up on welding nozzles, and to obviate this Linde have introduced a new silicone compound which can be applied to the nozzle before welding. This forms a thin protective coating which prevents spatter from sticking. Under normal conditions a coating of the compound, which can be applied directly to the nozzle by hand, gives 8 hours' protection. When the current level is high, or welding conditions are unusual, the compound needs applying every 4 hours or less.

Gas cutting can be used profitably for short runs as well as long ones, but it is not always convenient to take short runs to a gas-cutting machine, which, in any case, may be fully occupied with routine work. A Linde customer has therefore mounted a Linde oxygen cutting head on a simple portable table, which can be wheeled to any position in the works where it is wanted. The table, which is of fabricated steel construction, is 6 ft. long and 3 ft. wide, and has a low-loading platform at one end for oxygen and acetylene cylinders. There are two fixed wheels at the platform end, and a detachable wheeled pick-up at the other. The Linde cutting machine rides on a 6 ft. track supported 12 in. above the table top by means of skids at each end, the skids in turn running on guide rails; the machine can thus be positioned at any point over the work.

Hard surfacing with weld metal is a well-known method of repairing worn parts. For carrying out this work on cylindrical surfaces another Linde customer has adapted an ordinary centre lathe. A Unionmelt submerged-arc welding head is mounted on the lathe saddle, and by using the lathe traverse a continuous helical line of weld metal is deposited as the work, held in the chuck and tailstock, is rotated. Welding speeds vary from 30 in. to 60 in. per minute, depending upon the thickness of the deposit. Earthing is by means of a sliding contact which bears against the outside diameter of the chuck.

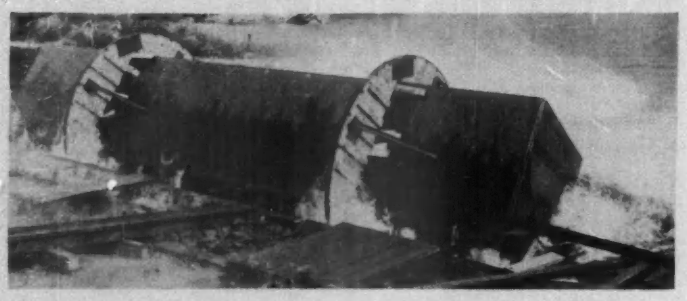
LAUNCHING BY ROLLING

An unusual method was adopted by Dravo of Canada Limited for the launching of the first hull constructed at their new shipbuilding yard at Deseronto, Ontario.

Designated Hull No. 1, the box-like vessel is an all-welded steel pontoon and will ultimately become a deck barge or part of a sectional derrick boat. Two circular yokes were attached to the vessel to facilitate moving it during the welding of the steel plates and, taking advantage of these yokes, the launching was achieved by merely rolling the craft, which is 50 ft. long, 9 ft. wide and 8 ft. deep, down the slipways. The yokes were then removed when the pontoon was afloat. Fitting out is being undertaken at the dockside.

Six identical pontoons are under construction at the Deseronto Shipyard and it is intended that they shall be launched at the rate of one a week. Whether used as barges or for derrick boat hulls, these vessels will be employed in connection with the firm's constructional operations. Plans are also being developed for the construction of barge hulls of conventional type at the shipyard.

Dravo of Canada has its main offices in Toronto and is a subsidiary of the Dravo Corporation, Pittsburgh, Pa., U.S.A., which is a very large builder of inland waterways equipment in the United States. The Deseronto Shipyard was acquired by Dravo of Canada in March last and will be used as the home port for Dravo's construction fleet. The yard is situated midway between Belleville and Napanee, in Ontario, and occupies the site of the former town dock as well as several acres of adjacent land. The firm has been operating in Canada for the past three and a half years.



A 50 ft. steel pontoon is launched by being rolled into the water on the circular yokes used in its construction.

★ ★ ★

1958 CENSUS OF PRODUCTION

Less Information from Fewer Firms

Arrangements are now being made by the Board of Trade for taking the 1958 census of production, which will be the first detailed inquiry of this kind since 1954. To enable the forms to be completed more easily, less information will be asked for than previously and full particulars will be required only from firms employing more than 24 persons on productive work.

In accordance with the recommendations of Sir Reginald Verdon Smith's Committee on Censuses of Production and Distribution, which reported in 1954 (H.M.S.O., Cmd. 9276, 1*s.* 6*d.*), complete returns for 1958 will be made by only 50,000 industrial establishments, compared with abut 71,000 in the 1954 census. Of the smaller firms, only 17,000 instead of 107,000 will be asked questions respecting their sales; and 86,000 firms will be relieved of their obligation to make returns. Although the larger establish-

ments will still be required to make full returns, they will be asked only general and not detailed questions about their purchases of materials and fuel.

Forms for completion will be issued in January, 1959, and, between now and the end of this year, advance notification of the questions to be asked will be given to the firms concerned by the issue of notes and specimen copies of the census forms. The information required will correspond more closely than previously to what is covered by firms' ordinary records. Combined returns containing particulars for two or more separate establishments will be accepted, provided that the establishments are all in the same census industry and in the same country (England, Scotland or Wales). Small firms in certain industries will be asked simple questions concerning sales and other activities but, for 1958, these questions will be limited to a sample of small firms.

The census forms will include questions on working proprietors, employment, wages and salaries, materials and fuel purchased, work given out, transport costs, stocks, capital expenditure, sales and work performed. Questions about the number of outworkers and their remuneration have been omitted, and there has been a reduction in the amount of information required in respect of the individual establishments which are grouped together in a combined return.

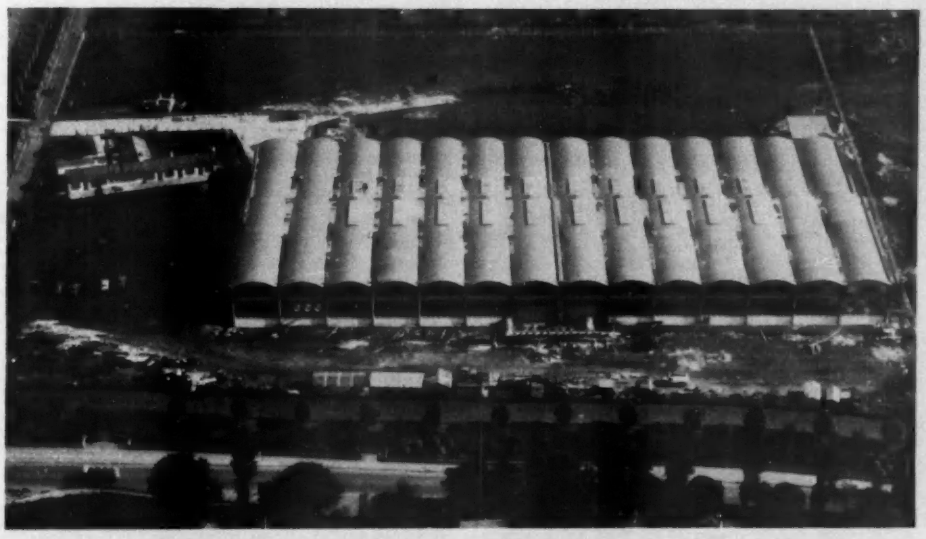
There will be one additional question whereby, in the wages and salaries section, firms will be asked to divide the salaries paid to administrative, technical and clerical employees in October, 1958, between those paid, respectively, to men and to women. Inquiries regarding any aspect of the census should be addressed to the Census Office, Board of Trade, Lime-grove, Eastcote, Ruislip, Middlesex. (Tel.: Pinner 9800, extension 28).

PRODUCTION OF GEAR HOBBERS

NEW FACTORY FOR CHURCHILL GEAR MACHINES

Churchill "Rigidhobbers," gear shavers and sound testers were first made in Newcastle-upon-Tyne some ten years ago, when Churchill-Redman Limited, of Halifax, set up a manufacturing organisation in leased premises at Scotswood. In March, 1956, the business was taken over by Churchill Gear Machines Limited, a newly-created subsidiary of Charles Churchill and Company, Limited, and at about the same time it was decided to build a new factory. A site was chosen at Blaydon-on-Tyne, Co. Durham, not far from the old premises, and the main construction contract was let to Mowlem (Scotland) Limited, 64 Frederick-street, Edinburgh, 2, in November, 1956. The factory is now in full production, having been formally opened by Lord Lawson of Beamish, D.C.L., Lord Lieutenant of the County of Durham, on September 28. Designed by Mr. J. M. Angus, L.R.I.B.A., of Newcastle, with the British Reinforced Concrete Engineering Company, Limited, Stafford, as consultants for the concrete work, the factory is a barrel-vault roofed structure covering 94,000 sq. ft., and divided into four longitudinal bays. Two of the bays are 36 ft. high and the other two are 24 ft., the lower bays being devoted to light machining and the higher ones to heavy machining and machine erection. The whole of the factory walling from 5 ft. above floor level to the roof is glazed; natural lighting, as a consequence, is very good.

The site of the factory was formerly a waste tip, and the entire building is constructed on a piled foundation, 250 piles having been driven to depths varying from 45 ft. to 65 ft. by the sub-contractors, Dowsett Engineering Construction Limited, Newcastle. Over this foundation is a floor varying in thickness from 8 in. to 3 ft., with two layers of reinforcement. Above ground level the factory building, 438 ft. by 220 ft., is designed as a reinforced concrete structure with integral crane rails. It was constructed at an average rate of one barrel-vault roof every 2½ days, all the steelwork being prefabricated at floor level and lifted into position by a travelling tower crane.



The new Blaydon-on-Tyne factory of Churchill Gear Machines Limited has a barrel-vault roof and is particularly well provided with natural lighting.

LIGHTING AND HEATING

Much attention has been devoted to the question of working conditions. Not only is the natural lighting of a very high standard, but artificial lighting is also designed to give a uniform level of illumination throughout the factory. More than half the lighting is from colour-corrected 1 kW mercury vapour lamps, of which there are 56; these are supplemented by 100 lamps of the same type, but of 400 watts each. Adjustable, individual lights of the normal type are provided on the production machines. Heating is by means of nine oil-fired heating units supplied by the Dravo Division of Weatherfoil Heating Systems Limited, 19 Berkeley-street, London, S.W.1, each unit being equipped with individual thermostatic control. Fuel oil is pumped to the heaters from two storage tanks near the factory entrance. The heater units can also be used for air circulation for ventilation purposes when heating is not required. Vermiculite insulation is used in the barrel roofs to control heat loss during winter and to reduce

Transport in the light machining section is by small fork-lift truck and mobile crane.

Heavy machining and assembly areas are served by overhead electric travelling cranes, and stanchion mounted jib cranes are also provided.

Continuing Production

heat intake in summer. Ventilating fans are built into the barrel roof sections.

The factory was built very quickly, and the transfer from the old to the new premises was effected at an equally impressive speed. Certain new machine tools, which were on order while the new factory was being built, were delivered there, but most of the equipment had to be moved from the old works; this was only a mile or two away, but some items had to be taken by a circuitous route because of weight restrictions on a bridge over the River Tyne. The move was scheduled to take place during the two weeks of the annual holiday, and with a certain amount of assistance from outside contractors it was carried out exactly as planned. The workpeople, some 340 in all, left Scotswood to take their holiday and returned to work at Blaydon. There was no loss of production, and it is a matter of interest that output has increased, from the same men and machines in the new factory—a reflection on improved working conditions.

OPEN LAYOUT

The factory is designed with a minimum of internal partitioning. A large stores area at one end of the machining bays is arranged to receive raw materials from road vehicles, an overhead electric travelling crane spanning the whole area to facilitate unloading, stacking and removal to and from a range of saws which cut steel to the sizes required. Adjoining the stores area, which also stocks purchased components, is the machining section, the smaller machines being served by light mobile cranes and fork-lift trucks where necessary. Heavier machining is done in one of the two 36 ft. high bays, which is equipped with overhead electric travelling cranes and also has individual jib cranes with lifting blocks mounted on the roof stanchions.

Material can thus flow both longitudinally and laterally from the stores to the appropriate points for machining, and thence to the second of the 36 ft. high bays, the major part of which is devoted to machine assembly. Two overhead cranes are installed in this bay, one being of 5 tons and the other of 15 tons capacity. Machines can thus be assembled, tested and, when necessary, lifted in completely finished form on to road vehicles for dispatch. All the equipment necessary for completing the machines is provided immediately adjacent to the assembly bay; this includes a large Aerograph de Vilbiss paint spray booth with water-washed exhaust, and other paint spraying equipment.

A hardening shop and a gear shaver cutter production shop are in enclosed parts of one of the 24 ft. high bays, and there is a maintenance department, with its own materials and electricians' stores, at one end of the building. The tool room adjoins this department.

Atomic Review

Fusion Hot and Cold

Scientists rarely thrive in isolation. Exchange of ideas is necessary to them. The medium for exchange may vary widely but conferences often play an important part. The Physical Society, for example, find that "the conference type of meeting has proved particularly valuable to physicists working in Universities and in Government and Industrial Research Establishments, since it provides ample opportunity for discussion, both formal and informal, on the material presented."

Conference on Plasma and Atomic Physics

The recent conference on plasma and atomic physics, organised by the Physical Society, put this statement to test. Informal discussion was clearly of great value. Delegates from different countries were able to talk over experimental and theoretical snags they had met in their individual laboratories. Formal discussion, however, was of less value: it became severely limited by the large number of papers presented. Eleven were on the programme for the first morning, so little time remained for questions from the floor.

Experimental work on gas discharges provided the topic for many conversations. Since the idea of getting useful energy from thermonuclear reactions in such discharges was put forward, the subject has received intense study in many countries. Industry's increasing demand for energy has led many governments to put research on thermonuclear fusion high on their list of priorities. Laboratories with such backing make constant progress in the subject, and their experimental results always arouse interest. It was natural then that informal groups should discuss the problems of enclosing an ionised gas, or plasma, at a temperature of several million degrees, of introducing electrodes to carry the high current impulses into such a gas, and of switching the current. The last topic received emphasis in one of the main papers read.

High Current Plasmas at Aldermaston

Details of recent work aimed at increasing switch efficiency were given in a paper "Neutron Emission in High Current Discharges," by Dr. H. A. B. Bodin and Dr. J. A. Reynolds, A.W.R.E., Aldermaston. In reading the paper, Dr. Reynolds said that a study was being made of plasmas produced by high current transient discharges in a linear tube. With deuterium in the tube, short bursts of neutrons had been observed. Some of the neutrons were possibly of thermonuclear origin. In contrast to the published Russian results, little X-ray radiation was observed. Compared with the Russian results, a higher neutron yield was achieved using a lower applied voltage.

At the energies reached in the plasma, two thermonuclear reactions were equiprobable:

$$D + D = He^3 + n$$
$$D + D = T + p$$

The necessary energies occur when a "pinch" develops in the discharge, as a result of the interaction between the current and its own magnetic field. Violent contractions are caused by the interaction, and shock waves are produced. Heating is caused both by the mechanical contraction and by the shock waves. The improved switching system at Aldermaston produced pinches of greater energies than have previously been obtained.

Basically the equipment used for plasma experiments is simple. A switch connects a charged condenser across two electrodes in gas at a low pressure. In practice a more complex circuit arrangement is needed if the current is to be built up rapidly. At Aldermaston a bank of condensers and a large number of switches were used. Spark gaps acted as switches and a complex system of trigger pulses provided the correct sequence of breakdown of what may amount to over a hundred gaps. All the gaps operate in 10 milli-microseconds. The system works at voltages between 1 and 10 kV.

Inductance dictates the rate of current rise in the circuit. The new switching system has an inductance of about 10 milli-microhenries—a value very much lower than that of a single-switch circuit. The condenser capacity amounts to 120 microfarad, the bank having a diameter of about 15 ft. and a height of about 10 ft. Work is at present in progress on a system for switching at between 10 and 100 kV. At such voltages the reduction of inductance becomes more difficult.

Deuterium was put in the straight quartz tube last February. The gas pressure was 30 microns. When a voltage of 8 kV was applied, a $\frac{1}{2}$ microsecond pulse of between 10^4 and 10^5 neutrons resulted. The pinch lasted for between 1 and 2 microseconds. A peak current of 210 kA was reached.

The number of neutrons obtained exceeds the number reported by other experimenters by 2 to 3 orders of magnitude. It is thought that a large number were due to instabilities in the discharge. A sketch of the type of current variation occurring in the course of the discharge is shown in Fig. 1. The initial oscillation in the curve represent successive pinches. The first two are repeatable but the remainder are of an erratic nature.

It is thought that neutrons are produced at instabilities by the high transient voltages that develop there. The violent contraction yields a rapid rise in inductance that can produce transients of 50 kV across the neck of the instability. Neutrons produced by thermonuclear reactions and by instabilities are difficult to distinguish. The only difference is that the former emerge from the plasma in random directions, whereas the latter should have a distribution related to the transient axial field at the instability. At present, however, the neutron yield is too low for measurements to be made. For proton-recoil measurements in photographic emulsions neutron yields of 2 to 3 orders of magnitude higher are required. But some yields were above those predicted by simple instability theory, and it is likely that a few thermonuclear neutrons were produced.

A small axial magnetic field tended to reduce instability and quench the neutron yield. The field extracts energy from the pinch and so cools it. Variation of neutron yield with field strength follow the expected theoretical relationship fairly closely. A field strength of 100 gauss was sufficient to quench the yield. Impurities in the deuterium also produce cooling. It was found that about 5 per cent. of nitrogen reduced the neutron yield by 2 to 3 orders of magnitude.

Shock Tube Plasmas at Harwell

In another paper some Harwell experiments with shock tubes were outlined. Plasmas are produced in supersonic shock waves and by photographing the plasma as it travels down a

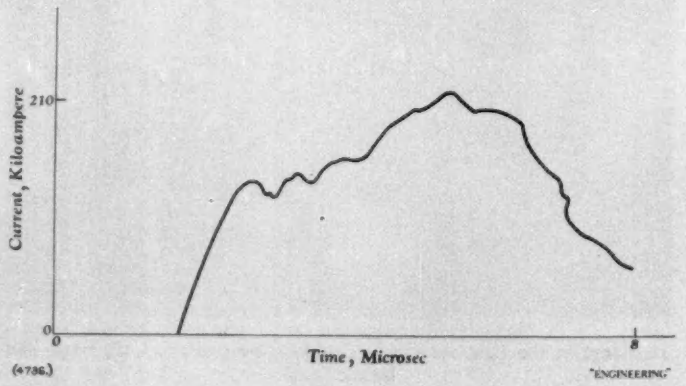


Fig. 1 In this sketch of the behaviour of the current during a discharge through deuterium, the oscillations in the curve represent the formation of successive pinches.

glass tube useful information can be gained. A simple plate camera can be used, the plate being exposed during the complete travel of the plasma.

In the interaction between a plasma and a magnetic field a magneto-hydrodynamic equation must be satisfied, namely,

$$R_1 \equiv B L \sigma \sqrt{\frac{4\pi\mu}{\rho}} \geqslant 1$$

where L relates to the dimensions of the system, B is the flux density, σ the conductivity, μ the permeability and ρ is the density. In astronomical systems the equation is satisfied because L is very large; however, controlled experiments are impossible. In high-current transient discharges the equation is satisfied because B and σ are large; but controlled experiments are extremely difficult. In the shock tube it is possible to make controlled experiments and to vary B and ρ as desired.

The advantages of the shock tube are: its simplicity; the absence of electric and magnetic fields in the plasma; the fact that measurement of the speed of travel of the plasma yields the values of pressure, temperature, conductivity, and density existing for the experiment.

At Harwell a Mach number of 17 was reached in argon. With no axial magnetic field applied, the plasma passed down the tube as a disc. On the single-exposure photographic plate it appeared as a column of uniform luminosity. The same picture resulted with small magnetic fields. However, with an axial field strength of 30,000 gauss, a complex diamond pattern was produced. From measurements of B, L, σ, μ, ρ it was inferred the $R \geqslant 0{\cdot}3$ produces a pattern of magneto-hydrodynamic interaction. Further studies are being made of the development of the interaction by use of a rotating-mirror camera.

Cold Fusion

In a paper "Cross-sections for Collisions between Deuterium and Mu-mesic H Atoms," by Dr. I. C. Percival and Dr. F. Haas, details were given of recent calculations. Negative mu-mesons catalyse a proton-deuteron fusion in a liquid-hydrogen bubble chamber through the formation of the $H D\mu^+$ ion. Theoretical cross-sections have been obtained for the processes

$$H\mu + D^+ \rightarrow D\mu + H^+$$
$$D\mu + H^+ \rightarrow H D\mu^+ + h\nu$$

that lead to the formation of this ion. The total wave function was approximated by

$$\phi(r_p)\, F(R) + \psi(r_d)\, G(R),$$

where ϕ and ψ represent the ground states of $H\mu$ and $D\mu$, and R is the inter-nuclear co-ordinate. The potentials were compared with the kernels arising from the expansion in centre-of-mass co-ordinates, and the coupled differential equations solved numerically.

Over 30 papers were read at the conference, some being allowed little more than 10 minutes for delivery and discussion. And although attention has been concentrated on fusion in the preceding paragraphs, many other aspects of atoms and plasmas were considered, the second—and last—day being devoted entirely to ionospheric physics.

General Notes

International Atomic Energy Agency

The first general conference of the International Atomic Energy Agency opened in Vienna on October 1. Of the 81 countries party to the I.A.E.A. statute, 62 sent delegations, of which 48 including Britain, the United States and U.S.S.R. are full members. Discussions of I.A.E.A. appeared in Atomic Review last April 19 and on May 25, 1956. Mr. Lewis L. Strauss, chairman of the United States Atomic Energy Commission, who led the United States delegation, stated that America is to present the Agency with a research reactor, an isotope laboratory, and a complete technical library in addition to the 5,000 kg. of fissile material already pledged by President Eisenhower. The United States also undertakes to make available to the Agency further nuclear materials to equal all quantities supplied by other nations up to July 1, 1960. Sir Edwin Plowden, chairman of the United Kingdom Atomic Energy Authority repeated his statement that Britain would provide 20 kg. of uranium 235 and undertake the development of reactors for smaller countries. Britain has also a wealth of practical experience to contribute. The Soviet Union are also to offer fissile material.

The Agency will serve as a clearing house for nuclear information and provide facilities for training. It will also act as an intermediary for the distribution of fissile materials, services and equipment, with special reference to the under-developed nations.

Neptune at Harwell

It has been reported that Neptune, a prototype for submarine propulsion, is likely to become critical in the near future. Neptune, which is understood to be a pressurised-water reactor, is located at the Atomic Energy Research Establishment, Harwell.

Engineering Test Reactor Critical

The Engineering Test Reactor, America's largest and most advanced nuclear test facility, has been placed in operation at the National Reactor Testing Station, in southern Idaho. Criticality was achieved on September 19. The reactor, which cost 14 million dols., and its related experimental facilities will be operated for the United States Atomic Energy Commission's programmes by the Atomic Energy Division of Phillips Petroleum Company, which also furnished the ETR's conceptual design. Kaiser Engineers, a division of the Henry J. Kaiser Company, performed the design and construction work. General Electric Company designed the reactor tank, core and controls under subcontract to Kaiser. Construction of the reactor, completed on August 31, 1957, required 23 months. The ETR's neutron flux average of $1{\cdot}9 \times 10^{15}$ neutrons per sq. cm. per second is the highest known in a test reactor. The test spaces, measuring up to 9 in. by 9 in. by 36 in., are said to be the largest in any test reactor now in operation for accommodating reactor components. The reactor is cooled and moderated by light-water, fuelled with enriched uranium, and has a thermal rating of 175 MW. The active core is 36 in. high by 30 in. square and is designed to accommodate experimental facilities vertical and parallel to the fuel assemblies.

Plutonium in ETR

Mr. Louis H. Roddis, deputy director of the U.S.A.E.C.'s reactor development division, is reported to have said that ETR will later be operated on plutonium fuel. This may mean, of course, that plutonium will be tested in experimental channels.

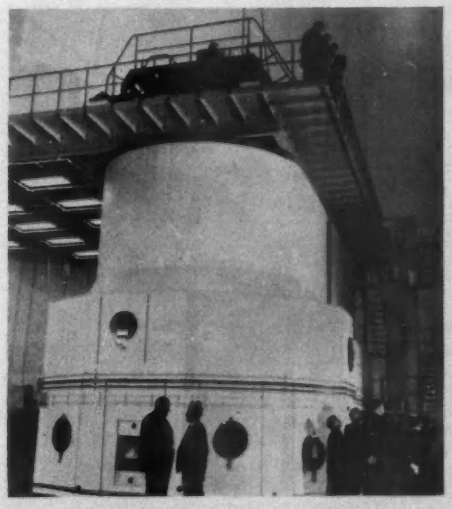


Fig. 2 Germany's first reactor is of swimming-pool design and intended for research. The basin is 6 ft. thick and holds 200 cub. metres of water.

West German Reactor

The Bavarian Prime Minister, Dr. Wilhelm Hoegner, handed over the first atomic reactor in the Federal German Republic on September 9. It is situated at Garching, near Munich. In Fig. 2 is shown an exterior view of the reactor basin. It is over 6 ft. thick and holds 200 cub. m. of water. The reactor core is suspended 32 in. from the bottom of the pool. The United States have sent West Germany 39 natural uranium bars, worth 60,000 dols., for starting up the reactor.

Spanish Nuclear Power Station

A plan to build a 132 MW nuclear power station, costing nearly £13 million, at Puerto Santa Maria, southern Spain, has recently been announced. Some £11 million of the equipment is to be purchased abroad.

Minimum U.S. Costs for Radioactive Isotopes

United States' estimates for the minimum prices of certain radioactive isotopes, given a considerable expansion of production, are shown in the table below. The figures are based on values of 7 dols. per milligram of neutrons (of which 4 dols. is production of materials and 3 dols. for chemical separation of isotopes), and on published prices for plutonium at 30 dols. per gram. Results are derived from the formula:

Cost in dols. per curie $= 3{\cdot}7 \times 10^{-3} T_{\frac{1}{2}}$

where $T_{\frac{1}{2}}$ is the mean half-life of the radio-isotope in minutes. It provides a ready method for calculating rock-bottom costs and serves to indicate which isotopes are capable of large-scale industrial applications from the point of view of their price. The formula indicates that the lower the mean half-life, the lower the cost, but it is not intended to be applied to isotopes of very short half-lives because in such cases the decay factor and the shipping problems would raise the real cost to the user.

Isotope	Half-life	Minimum cost (per curie)	Present selling price (dols. per curie)
(*a*) Non-transmuted neutron-produced isotopes:			
Cobalt 60 . .	5·3 years	6 cents	2 to 5
(*b*) Chemically-transmuted neutron-produced isotopes:			
Tritium (H^3)	12·26 years	25 cents	2
Carbon 14 .	5,600 years	110 dols.	22,000
Sulphur 35 .	87 days	0·5 cents	2,000
(*c*) Fission products:			
Iodine 131 . .	8 days	0·04 cents	400
Caesium 137	33 years	30 cents	10

Food Preserved by Irradiation

Food preserved by radiations is not likely to be seen in the shops for some years. This was the conclusion at the Symposium on Irradiated Foods held at Cambridge on September 26 and 27. When the researches on irradiated foods are completed, however, there is no doubt that it will provide cheap, wholesome, attractive and safe food. The discussions ranged over subjects such as the effect of radiations on typical food components, on various foods of animal origin, and of treatment of products such as cereal products and potatoes. The information presented gave a comprehensive background to the potentialities of these techniques in Britain. For example, irradiation of fresh meat and poultry could appreciably extend storage life under refrigeration. Some changes of quality had been observed and further work was required before such processes could be regarded as commercially applicable. However, in the treatment of frozen whole egg pulp, to eliminate *Salmonellae* food poisoning, there was good promise, in that the damage to the product so far observed has been relatively small and that

the advantage to be gained from successful treatment would be considerable. One of the most interesting aspects of the discussions was the consideration devoted to the economic side of the application of irradiation to foodstuffs. For example, the irradiation of potatoes to prevent sprouting showed that the potato could not stand a charge of more than about 6*s*. a ton for irradiation.

Exhibition to Show Dounreay Research

An exhibition which will open at 10 Carlton House-terrace, S.W.1, on November 5, will show some of the research and development work which has been undertaken by the laboratories at Dounreay. It will be open for three days from 10 a.m. to 8 p.m. The reactor now under construction, which will come into operation early next year, is experimental, and the steps that will be taken to obtain information from it will be outlined. Stages in the development of the fuel elements, the metallurgy and fabrication of the fuel and canning and post-irradiation research on the fuel elements will be demonstrated, as well as methods of re-processing spent fuel to eliminate fission products and recover unused fuel and plutonium. The use of liquid sodium at high temperatures in the heat-exchange circuits presents problems of corrosion, pumping and flow. Methods used in solving these problems will be shown. Research managers from the various laboratories will attend the exhibition to answer questions.

Passing on Construction Know-How by Films

The number of engineers and technologists who have had first hand experience of the kind met in constructing the Calder Hall nuclear power station and the fast breeder reactor at Dounreay is obviously very limited. This is particularly significant in view of the number of nuclear power stations projected in the future. The U.K.A.E.A. having a commitment to train British industry in the techniques of building nuclear reactors for power production, have made a series of films which graphically pass on the knowledge gained at Calder Hall and Dounreay.

The films, produced by Ace Distributors, Limited, 14 Broadwick-street, Wardour-street, London, W.1, from whom 16 mm. and 35 mm. versions are available can be loaned free of charge. Those immediately available are "The Construction of Calder Hall," running 40 minutes, "Heat Exchangers at Dounreay," 28 minutes, "Engineering at Calder Hall," 39 minutes, and "The Dounreay Sphere," 35 minutes.

Automobile Engineering

THE FRENCH MOTOR INDUSTRY

Expansion Continues Despite Punitive Taxation

By Gordon Wilkins

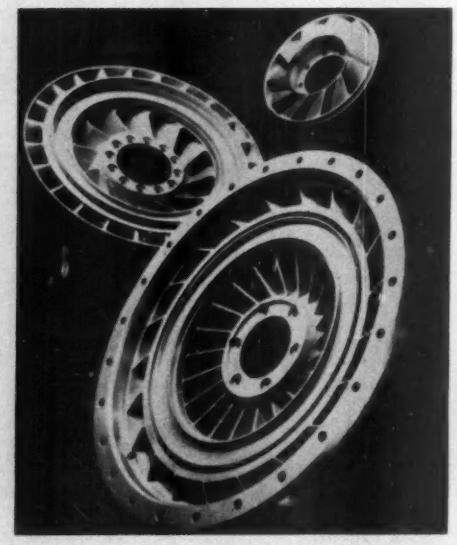
The French motor industry is showing its latest cars this week at the Grand Palais in Paris, and its commercial vehicles in another vast branch of the exhibition at the Porte de Versailles. Like its British counterpart, it is exhibiting the fundamental resilience typical of this essential industry, despite the most repressive taxation. Production of passenger cars for the six months January to June was 327,967 against 345,533 for the corresponding period last year, and buses, coaches and commercial vehicles brought the total up to 473,277, against 432,316. Exports for the six months period totalled 126,706 units, against 92,873 for the first half of last year, and some 26,000 of the increase was represented by vehicles exported to foreign countries outside the French overseas possessions.

Taking the figures to the end of July, the total for this year was 566,500 units against 512,000 for the corresponding period last year, an increase of 10 per cent., which is about the same as that achieved by West Germany during the same period. Yet the French industry, like our own, laboured under special difficulties, above all the effects of the Suez crisis and of petrol rationing. Petrol is still rationed in effect by price, and the tax on ownership weighs with particular severity on medium and large cars, which, when new, are taxed at up to £85 per annum (one effect of this has been to slash production of the V8 Simca Vedette from 27,468 for the first six months of 1956, to 10,856 for the first half of this year).

To the visitor from Britain, the extensive road works in Paris and outside look very impressive, but in terms of road expenditure for vehicles in use, France is only one rung above Britain. Yet French motor vehicle taxes now amount to £66 10*s*. per annum per vehicle, and have increased by 34 per cent. during the past three years. Against this unpromising background, the industry is making solid progress at home and abroad, and is increasing its exports at a more rapid rate than Great Britain—which is natural, as there was a good deal of leeway to make up. As at home, the "democratisation" of car ownership continues—if one may use such a cumbersome word to describe the refusal of the ordinary man to be deflected by government discouragement from owning his own transport—and last year it is estimated that 17 per cent. of new cars were bought by workmen and junior employees.

Against this background it is not surprising to find that the Dauphine produced by the nationalised Renault organisation accounts for just under 25 per cent. of all passenger-car production, and the Simca Aronde in its several variants comes next with 18 per cent. Against the competition of the Dauphine, the production of the original post-war Renault small car, the 750 c.c. 4 CV, has been almost halved in a year. The effort to popularise a miniature town car by making the Isetta under the name of Velam has also suffered a severe setback, production for the first half of the year being only 838 units, against 3,918 for the first half of last year.

Control gear for the "Transfluide."



The components of the Renault "Transfluide."

For next year, no major changes are being made to upset the rhythm of production. The Dauphine is being made available as a sports saloon in collaboration with Amédeé Gordini, the famous racing-car constructor. It has a four-speed, instead of three-speed, gearbox, and the engine is modified, but the extra performance has been kept below what was expected and is possible in the interests of reliability. The major new factor in the market is the production of the new Vespa small car, which is being built in France rather than Italy to avoid direct competition with the Fiat 500 on its home ground. The car is very like a Fiat 500 in outline and performance, but has a two-cylinder two-stroke engine instead of a four-stroke, and a three-speed synchromesh gearbox instead of a four-speed non-synchromesh box. The engine is a vertical twin of 393 c.c. with 6·4 to 1 compression, giving an amount of power which is at present unspecified; it is cooled by ducted fan. Mounted at the rear, the engine has a gravity-feed fuel tank above it. The body is a unit structure in steel with several points of interest, and the front suspension is by long coiled-spring struts which also form steering pivots, rather like the system on the English Fords, but with differences of detail and geometry. Rear suspension is independent, by single wishbones giving simple swing axle geometry. There are seats for two adults, and space behind for luggage or for two children, but it is not upholstered.

In transmission development, the French industry finds itself somewhat behind the British. Simca offer a vacuum-operated automatic clutch, and Renault were early in the field with the electromagnetic Ferlec. Now, however, Peugeot are offering an electromagnetic powder clutch based on Eaton patents, but it is of the early type, with heavy rotating magnets; this version is technically behind the Smiths' version, on which the windings are stationary with consequent benefit to acceleration, and which is being introduced as an optional extra on the British-made Isetta.

So far there has been no automatic transmission on offer in France for passenger cars, but Renault have produced a semi-automatic transmission, the "Transfluide" for the Fregate, consisting of a three-element fluid torque converter, a Ferlec clutch, and a three-speed synchromesh gearbox. A steering-column lever with visual selector, which is illuminated at night, is used to select the range required, which is smoothly engaged with the aid of the clutch, under control of a micro-switch in the lever. In effect, first, second and third speeds in the gearbox now become "emergency," "mountain," and "town-country" ranges on the transmission, and the conversion range on the fluid element is sufficient to permit starting and all normal running with only the top gear engaged. A useful by-product of the transmission is the way it smoothes out the operation of the four-cylinder 2·1 litre

Alpine testing of the new Vauxhall sixes included main roads, secondary roads—and just tracks.

engine, which was not the most smooth-running example of its kind.

Citroën, of course, have a simple centrifugal clutch on the 2CV, which makes it unnecessary to use the clutch pedal for starting and stopping, and an automatic clutch with servo-operated gear shift on the DS 19. Production of the 2CV is still far short of demand (54,935 units in the first half of this year), holding it down to third place among French car sales, and the prospect of competition from the Vespa has produced an announcement that production of the 2CV is to be increased progressively to 1,000 a day.

NEW VAUXHALL SIXES

Beyond the Victor

With the introduction of two new six-cylinder models for the Motor Show, Vauxhall complete the most comprehensive innovation they have ever carried out within the space of a year. The new cars are longer, lower and wider than those they replace, and glass areas are larger; but advancing experience with unit body chassis construction has enabled Vauxhall designers to keep the weight within a few pounds of that of the previous models. The cars were designed and developed in England, utilising the experience gained with the Victor, which was the subject of development by Fisher Bodies in the United States.

All four wings are permanently attached as stress-bearing panels, and the box section body sills, which are practically straight until the joint at the scuttle, form important structural elements. Mechanical design is quite conventional; in fact the 2,262 c.c. engine and the three-speed all-synchromesh have been fitted for some months past in the old models.

The bonnet panel extends across to the crowns of the front wings and opens wide, giving much easier access to the engine and auxiliaries than on the Victor. The boot lid is counterbalanced by torsion bars. Much of the exterior bright work is stainless steel, and the bumpers, which are chromium plated, are much more massive than is customary on British cars.

The brake lining area has been increased by 37 per cent. to 138 sq. in. The illustration shows a Vauxhall Velox prototype on test in the Swiss Alps. When on test abroad, the cars travelled with all the bright work removed or covered, and carried name plates of the Australian Holden to make identification more difficult.

Construction

PLANNED FOR EXPANSION

The firm of Dallow, Lambert and Company, Limited, Thurmaston, Leicester, have for many years specialised in the manufacture of equipment for collecting dust or fine particles. The presence of dust in the atmosphere is usually harmful both directly to health and indirectly by the risk of explosion. Moreover, in some processes the recovery of dust particles of expensive materials can represent a considerable saving. Recently the firm has opened a new factory at Thurmaston (previously they were in Leicester). Based upon a site of ten acres the first stage of the project has been completed with a building floor space of 56,000 sq. ft.

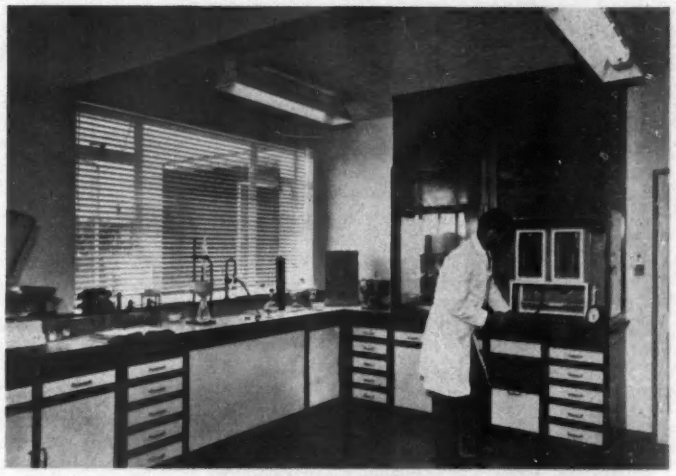
The office and factory layout was defined by the architect (Mr. Brian O'Rorke, R.A.) after careful study of the firm's system and method of producing equipment. A business "flow-sheet" was first outlined and the progress of work from inquiry stage to completion of contract carefully scrutinised. Thus the office block consists of four wings surrounding a lawn quadrangle. With the exception of the directors' suite and conference room above the entrance hall, the whole building is single-storey level. To cater for future expansion it has been designed so that a complete first floor can be added on all four wings and there is sufficient space behind the factory to allow large expansion of the works.

Enquiries are received by the sales department, passing to the engineering department for thorough analysis of the particular dust problem before specification of the proposed equipment. Consequently, a small-particles laboratory, in which the various dust samples received are subjected to searching investigation of their chemical properties, physical reactions and general size distribution, is sited between the technical sales department and the drawing office. Thus, as a routine, each sample of dust is given a physical and chemical analysis and has size distribution curves constructed, on which the choice of collecting plant depends. Adjacent to the drawing office is a demonstration bay, where full-scale tests can be carried out—on both wet dedusting and dry filtration plant—using customers' samples of powders.

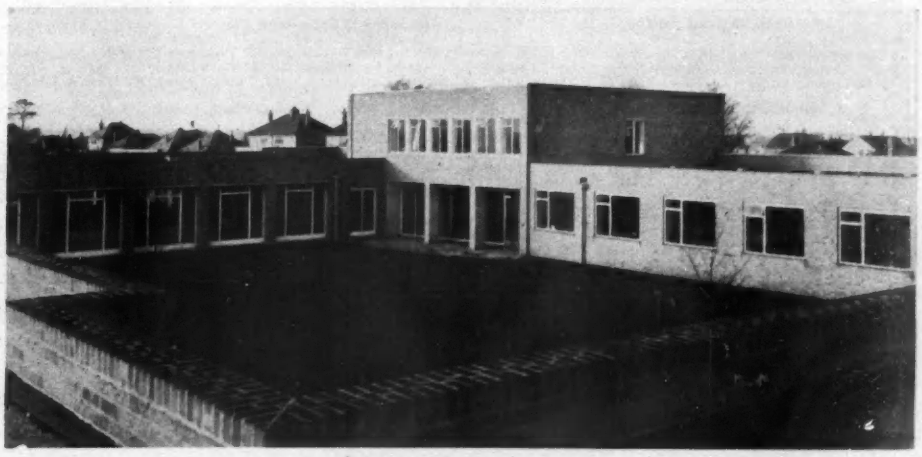
These processes occupy the north and west wings of the office block; research and development work of a more fundamental nature is carried out in a separate building and isolated from the routine business activity. The south wing of the main office block houses cost and works control and the east wing contains two large dining rooms and a small dining room for visitors, all served by a central kitchen; the two large dining rooms can be combined to form an assembly hall or cinema.

The office partitions are completely interchangeable to permit rapid and smooth adjustment of office areas. Steel partitioning constructed in three-foot sections has been used throughout and accessible ducts housing electric and internal and external telephone circuits run under every office floor. Noise has been reduced to a minimum by cork floors and acoustic-lined ceilings and particular effort has been made to ensure that nearly all offices have, at some time during the day, direct sunlight. In the works, lighting, both natural and artificial, has been arranged to give generally shadowless working conditions, and low vertical windows on the south wall provide an uninterrupted view of the grassland and trees at the rear of the site.

(Right) An essential process is the routine analysis of dust samples for chemical and physical properties and size distribution.



(Below) Built round a quadrangle, Dallow, Lambert's factory is mainly on one storey, but provision has been made for adding a second floor.



Continuing **Construction**

CROSS-CHANNEL CABLE APPROVED

The Minister of Power has formally approved in principle the provision of a high-voltage power interconnection between the electricity supply systems of the Central Electricity Authority and Electricité de France.

According to a statement issued by the Central Electricity Authority the principal items in this interconnection will include a 275 kV overhead line between Northfleet, Canterbury and a point near Dungeness; a converter station at Dungeness, where the incoming alternating current supply will be converted to direct current at 200 kV; a single submarine cable beneath the Channel to a second converter station to the east of Boulogne, where the direct current will be re-converted to alternating current at 225 kV; and a connection therefrom to the French 225 kV system. The submarine cable and the associated terminal equipment will have a nominal transmission capacity of 160 MW in each direction.

Most of the plant required in the construction of the terminal stations will be of conventional types and will be supplied by the industries in the two countries. The convertor plant will, however, be of special design in the construction of which only the Swedish company, ASEA, who have carried out the link between the Swedish mainland and the Island of Gotland, have had the necessary experience. To eliminate compass deviation in passing ships, the cable will contain two insulated conductors to form a "go" and "return" circuit, the arrangement being such that although the operating voltage will be 200 kV between conductors their potential above and below earth will be only 100 kV.

The use of this maximum potential makes it possible to consider the employment of a "solid" paper-insulated or polythene-insulated cable. The latter would lead to greater simplicity and reduced cost, but the introduction of such a new material for high-voltage working will necessitate further experimental work. One half of the cable, which will be about 35 miles long, will be manufactured in this country and one half in France, and tenders for its supply are being examined. The route now selected is rather longer than that originally chosen, but the latter involved crossing some communication cables at an acute angle and was considered to be more subject to interference from external causes.

As regards the economics of the scheme it is estimated that the total cost (excluding the extensions required to the present systems to couple in the interconnectors) will be about £4 million. The British portion of this expenditure will, however, be offset by savings on generating plant. Similar savings may also be anticipated in France, although these are more difficult to assess owing to the employment of both hydro-electric and steam generation. In addition, there will be savings owing to operational energy exchanges between the two countries and it has been estimated that there will be an overall economy of £300,000 per annum or more.

Before plans for laying the cable can be finalised, the route settled in detail and work started, further consultation will be necessary with other bodies, such as the Post Office and the maritime authorities. Nevertheless, it is hoped that the project can be completed in time to assist with the winter load in 1960-61.

REVOLUTION ON THE LANDING STRIP ?

There has been growing concern for some time about the present inadequacy of control systems for aircraft at the approaches and landing strips of some international air terminals and the future inadequacy at even the best of them if the present trend of air traffic density continues. A recent report in the United States drew attention to the need for revolutionary thinking if air traffic 10 years from now is to be handled efficiently at American airports. There has been growing concern in Europe about the density of traffic on international routes and the gradual emergence of a dangerous "rush hour" element on the North Atlantic run.

A special report has been issued by a panel of the Air Navigation Commission of the International Civil Aviation Organisation dealing with the needs of aviation in the coming jet age. The report offers a formidable list of requirements in the way of civil engineering construction and control equipment. It considers that it may be necessary to provide runways resistant both to heat and blast at run-up areas and at the ends. Special attention is required for the joints and jointing materials on concrete pavements, and compositions resistant to the chemical effects of spilled jet fuels are needed at aprons and refuelling positions. Runways must be laid out to allow for the minimum of taxi-ing time and for turns at speeds between 30 and 45 knots owing to the uneconomic fuel performance of jets on the ground and the need to make them airborne in the minimum of time, so reducing fuel costs.

Recommendations are made about improved navigational aids. Provision must be made for accurate flying along reasonably closely spaced tracks. A speed-up in the flow and accuracy of information between pilot and ground control will be necessary, and greater care will have to be taken in planning flying lanes and altitudes to prevent jets paying a high penalty in terms of fuel consumption for changes of altitude. All these changes will have to come in substance in the next 10 years or so with consequential strains on research staff and training facilities for the men who are to build and use the airports of the future.

NOTICES OF MEETINGS

Association of Supervising Electrical Engineers

LONDON
"Isotopes," by F. H. Gottfield. Central London Branch. White Hall Hotel, Bloomsbury-square, W.C.1. Mon., Oct. 14, 6.30 p.m.
OXFORD
"The Work of the National Inspection Council for Electrical Installation Contracting," by E. J. Sutton. Oxford, Reading and Districts Branch. Regent's Park College, Pusey-street, Oxford. Sat., Oct. 19, 7 p.m.
WESTGATE, THANET
Film Evening. Kent Branch. St. Mildred's Hotel, Westgate, Thanet. Thurs., Oct. 17, 7.30 p.m.

Birmingham Exchange and Engineering Centre

BIRMINGHAM
"Trade Unions To-day," by W. J. Carron. Fri., Oct. 18, 6.30 p.m.

British Computer Society

LONDON
"The Machine's Eye View," by Professor D. R. Hartree. Senate House, Malet-street, W.C.1. Mon., Oct. 21, 6.15 p.m.*

Building Centre

LONDON
Film Display: "Rubber in Engineering" and "Rubber in Roads," exhibited by the Natural Rubber Development Board. Wed., Oct. 16, 12.45 p.m.

Chemical Society

LONDON
Tilden Lecture on "Crystalline Ion Exchangers," by Professor R. M. Barrer. Imperial College of Science and Technology, South Kensington, S.W.7. Thurs., Oct. 17, 7.30 p.m.

Combustion Engineering Association

LONDON
"A Survey of Boiler Cleaning Methods," by R. H. Thompson, at 10.30 a.m.; and "Planning the Installation of New Boiler Plant," by G. H. Buckle, at 2.30 p.m. Southern Region. St. Ermin's Hotel, Caxton-street, S.W.1. Wed., Oct. 16.

Diesel Engineers and Users Association

LONDON
Annual General Meeting. "Diesel Electricity Generation in the Isle of Man," by F. J. Riches. Caxton Hall, off Victoria-street, S.W.1. Thurs., Oct. 17, 2 p.m.

Illuminating Engineering Society

LIVERPOOL
Chairman's Address, by W. B. Parkinson. Liverpool Centre. Liverpool Passenger Transport Office, 24 Hatton-garden, Liverpool 3. Tues., Oct. 15, 6 p.m.
MANCHESTER
"The Stage and the Lighting Engineer," by F. P. Bentham. Manchester Centre. North Western Electricity Board's Offices, Town Hall, Manchester 2. Thurs., Oct. 17, 6 p.m.*
MIDDLESBROUGH
"Interior Decorating and Lighting," by L. Wilson. Tees-Side Group. Cleveland Scientific and Technical Institution, Corporation-road, Middlesbrough. Wed., Oct. 16, 6.30 p.m.
SHEFFIELD
Chairman's Address, by F. Smith. Sheffield Centre. Grand Hotel, Sheffield. Mon., Oct. 14, 6.30 p.m.

Incorporated Plant Engineers

BIRMINGHAM
"Planned Maintenance for Equipment on Building Sites," by Walter T. Scopes. Birmingham Branch Mobile Plant Discussion Group. Imperial Hotel, Lower Temple-street, Birmingham. Fri., Oct. 18, 7.30 p.m.
BLACKBURN
"Man Management," by Dr. A. Roberts. Blackburn Branch. Golden Lion Hotel, Blackburn. Thurs., Oct. 17, 7.30 p.m.
DUNDEE
"Boiler Feed Systems and Auxiliaries," by J. R. Cairns. Dundee Branch. Mathers Hotel, Dundee. Mon., Oct. 14, 7.30 p.m.
ROCHESTER
"The Generation of Power from Atomic Energy," by H. R. M. Hyder. Kent Branch. King's Head Hotel, High-street Rochester. Wed., Oct. 16, 7 p.m.

Institute of Marine Engineers

LONDON
Film Display: "Super Tanker" and "Foothold on Antarctica." Students' Meeting. Mon., Oct. 14, 6.30 p.m.*

Institute of Packaging

BRISTOL
Discussion on "The Packaging of Tobacco: Pipe Tobacco, Cigarettes and Cigars." South Western Branch. Royal Hotel, Bristol. Fri., Oct. 18, 6.30 p.m.

Institute of Physics

LONDON
"Dense Electron Beams," by Dr. B. Meltzer. Electronics Group. Tues., Oct. 15, 5.30 p.m.*
CARDIFF
"Structural and Physical Properties of Alloys," by Professor H. Jones. South Wales Branch. University College of South Wales, Cardiff. Fri., Oct. 18, 5.15 p.m.
LEEDS
"Nuclear Magnetic Resonance in Solids," by Professor E. R.

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this column should reach the Editor not later than Monday morning in the week preceding the date of the meeting.

* An asterisk is placed where it is understood that tea is available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury-square, London, W.C.1. (LANgham 5927.)
Birmingham Exchange and Engineering Centre, Stephenson-place, Birmingham 2. (Midland 1914.)
British Computer Society, 29 Bury-street, St. James's, London, S.W.1.
Building Centre, 26 Store-street, London, W.C.1. (MUSeum 5400.)
Chemical Society, Burlington House, Piccadilly, London, W.1. (REGent 0675.)
Combustion Engineering Association, 6 Duke-street, St. James's, London, S.W.1. (WHItehall 5536.)
Diesel Engineers and Users Association, 19 Old Queen-street, London, S.W.1. (TRAfalgar 5597.)
Illuminating Engineering Society, 32 Victoria-street, London, S.W.1. (ABBey 5215.)
Incorporated Plant Engineers, 12 The Parade, Solihull, Warwickshire. (Solihull 1111.)
Institute of Marine Engineers, 76 Mark-lane, London, E.C.3. (ROYal 8493.)
Institute of Packaging. Apply to Mr. H. Williams, 80 Lancaster-avenue, London, S.E.27. (TEMple Bar 3422.)
Institute of Physics, 47 Belgrave-square, London, S.W.1. (BELgravia 6111.)
Institute of Road Transport Engineers, 69 Victoria-street, London, S.W.1. (ABBey 6248.)
Institution of Chemical Engineers, 16 Belgrave-square, London, S.W.1. (BELgravia 3647.)
Institution of Civil Engineers, Great George-street, London, S.W.1. (WHItehall 4577.)
Institution of Electrical Engineers, Savoy-place, Victoria-embankment, London, W.C.2. (TEMple Bar 7676.)
Institution of Engineering Designers, 38 Portland-place, London, W.1. (LANgham 8847.)
Institution of Heating and Ventilating Engineers, 49 Cadogan-square, London, S.W.1. (SLOane 3158.)
Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, London, S.W.1. (WHItehall 7476.)
Institution of Mining and Metallurgy, 44 Portland-place, London, London, W.1. (LANgham 3802.)
Institution of Production Engineers, 10 Chesterfield-street, London, W.1. (GROsvenor 5254.)
Institution of Public Health Engineers, 118 Victoria-street, London, S W.1. (VICtoria 3017.)
Junior Institution of Engineers, Pepys House, 14 Rochester-row, London, S.W.1. (VICtoria 0786.)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle-upon-Tyne 1. (Newcastle 20289.)
Physical Society, 1 Lowther-gardens, South Kensington, London, S.W.7. (KENsington 0048.)
Plastics Institute, 6 Manville-place, London, W.1. (WELbeck 5439.)
Reinforced Concrete Association, 94-98 Petty France, London, S.W.1. (ABBey 4504.)
Royal Meteorological Society, 49 Cromwell-road, South Kensington, London, S.W.7. (KENsington 0730.)
Society of Instrument Technology, 20 Queen Anne-street London, W.1. (LANgham 4251.)

Andrew. Physics Department, The University, Leeds. Wed., Oct. 16, 3 p.m.

Institute of Road Transport Engineers

DURHAM
"Research on the Testing and Performance of Commercial Vehicle Brakes," by R. D. Lister. North Eastern Centre. Three Tuns Hotel, Durham City. Tues., Oct. 15, 7.30 p.m.
LEEDS
"Oil Engine Injectors and Their Maintenance," by T. G. Charlesworth. Yorkshire Centre. Great Northern Hotel, Willington-street, Leeds, 1. Thurs., Oct. 17, 7.30 p.m.
LIVERPOOL
"The Design and Construction of a Modern Goods-Carrying Vehicle," by A. S. C. Marks. West Regional Centre. Liverpool Architectural Society, Bluecoat Chambers, School-lane, Liverpool 1. Tues., Oct. 15, 7.30 p.m.

Institution of Chemical Engineers

COVENTRY
"Use of Digital Computers in Planning Plant Operations," by D. A. Caplin. Midlands Branch. Acetate and Synthetic Fibres Laboratory, Lockhurst-lane, Coventry. Sat., Oct. 19, 3 p.m.
MANCHESTER
"Liquefaction of Hydrogen on a Commercial Scale: Technological Problems and Economics," by W. L. Seddon. North Western Branch. College of Science and Technology, Manchester. Tues., Oct. 15, 7 p.m.

Institution of Civil Engineers

LONDON
"An Investigation into a Proposal to Dispose of Power Station Ash by Discharging it into the Sea at Low Water," by F. L. Harwood and K. C. Wilson. Tues., Oct. 15, 5.30 p.m.*

Institution of Electrical Engineers

LONDON
Discussion on "The Social Consequences of Automation," opened by the President, T. E. Goldup. Mon., Oct. 14, 5.30 p.m.*
Chairman's Address on "Some Radio Aids for High-Speed Aircraft," by Dr. J. S. McPetrie. Radio and Telecommunication Section. Wed., Oct. 16, 5.30 p.m.*
Discussion on "The Architectural Features of Electrical Engineering Laboratories," opened by H. E. Dance and Dr. P. F. Soper. Education Discussion Circle. Fri., Oct. 18, 6 p.m.*
BRIGHTON
"Electrical Floor Warming," by J. W. Moule and W. M. Stevenson. Southern Centre. Brighton Technical College, Brighton. Wed., Oct. 16, 6.30 p.m.
CARDIFF
Chairman's Address, by J. F. Wright. Western Centre. South Wales Intitute of Engineers, Park-place, Cardiff. Mon., Oct. 14, 6 p.m.*
LEEDS
"Electrical Equipment for Rectifier Locomotives," by H. B. Calverley, E. A. K. Jarvis and E. Williams. North Midland Centre. Offices of the Yorkshire Electricity Division, 1 Whitehall-road, Leeds. Tues., Oct. 15, 6.30 p.m.
NEWCASTLE-UPON-TYNE
Chairman's Address, by T. W. Wilcox. North Eastern Centre. Neville Hall, Westgate-road, Newcastle-upon-Tyne. Mon., Oct. 14, 6.15 p.m.

Institution of Engineering Designers

NEWCASTLE-UPON-TYNE
"Building Structures," by G. Gladstone. North East Branch. Northern Architectural Association, 6 Higham-place, Newcastle-upon-Tyne. Mon., Oct. 14, 7.15 p.m.

Institution of Heating and Ventilating Engineers

LONDON
"Ventilation in the Atomic Energy Industry: The Hazard from Inhaled Radioactive Substances," by Dr. C. N. Davies. Institution of Mechanical Engineers, 1 Birdcage-walk, St. James's Park, S.W.1. Wed., Oct. 16, 6 p.m.*
BRISTOL
"Storage of Oil Fuel," by T. Chippindale. South Western Branch. Library of the R.W.A. School of Architecture, Bristol. Tues., Oct. 15, 6.30 p.m.

Institution of Mechanical Engineers

LONDON
Discussion on "The Effect of Modern Design on Repair Costs." Automobile Division. Tues., Oct. 15, 6.45 p.m.*
Presidential Address, by Sir George Nelson, Bt. Fri., Oct. 18, 6 p.m.*
DUNDEE
"The Steam Catapult," by Commander C. C. Mitchell and Captain Q. H. Paterson. Scottish Branch. Technical College, Dundee. Fri., Oct. 18, 7.30 p.m.
HULL
"Modern Blast Furnaces," by M. Adamson. Yorkshire Branch. Royal Station Hotel, Hull. Wed., Oct. 16, 7.30 p.m.
SLOUGH
"The Channel Tunnel Project," by Christopher Shawcross. Eastern Branch. Good Companions Hotel, Slough. Tues., Oct. 15, 7.30 p.m.

Institution of Mining and Metallurgy

LONDON
"Control of Air Pressure as an Aid to Fight Mine Fires," by J. M. Caw; and "Production of Zinc in a Blast Furnace," by S. W. K. Morgan. Geological Society, Burlington House, Piccadilly, W.1. Thurs., Oct. 17, 5 p.m.*

Institution of Production Engineers

LONDON
"Electronics as an Aid to Production, by T. A. Waite. London Section. Royal Empire Society, Northumberland-avenue, W.C.2. Thurs., Oct. 17, 7.15 p.m.
BIRMINGHAM
"The Technique of Tube Making," by L. C. Hackett. Birmingham Section. James Watt Memorial Institute, Great Charles-street, Birmingham. Wed., Oct. 16, 7 p.m.
BRISTOL
"Engineering in the Field of Atomic Energy," by J. R. V. Dolphin. Western Section. Engineering Faculty, The University, Bristol. Wed., Oct. 16, 7.15 p.m.
GLASGOW
Discussion on "Electronic Instrumentation." Glasgow Section. 39 Elmbank-crescent, Glasgow, C.2. Thurs., Oct. 17, 7.30 p.m.
HUDDERSFIELD
"Selecting the Right Man for the Job," by T. M. Higham. East and West Ridings Regional Meeting. George Hotel, Huddersfield. Wed., Oct. 16, 7.30 p.m.

Institution of Public Health Engineers

LONDON
"Removal of Sulphur Dioxide from Chimney Flue Gases," by A. Parker. Caxton Hall, off Victoria-street, S.W.1. Thurs., Oct. 17, 6 p.m.

Junior Institution of Engineers

LONDON
"Sub-Standard Films," by W. C. C. Ball. Fri., Oct. 18, 7 p.m.*

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE-UPON-TYNE
Film: "M.S. Bergensfjord." Apartments of the Literary and Philosophical Society, Newcastle-upon-Tyne. Fri., Oct. 18, 6.15 p.m.

Physical Society

LONDON
"Present State of Acoustic Theory as Applied to Small Rooms," by Dr. J. Moir. Acoustics Group. Physics Department, Imperial College, Exhibition-road, S.W.7. Tues., Oct. 15, 5.30 p.m.

Plastics Institute

LONDON
"New Developments in the Manufacture of Phenolic Moulding Powders," by E. Schneider and D. H. M. Brooks. 183-193 Euston-road, N.W.1. Tues., Oct. 15, 6.30 p.m.

Reinforced Concrete Association

LONDON
"Structural Design of Reinforced-Concrete Biological Shields," by P. A. Badland. 11 Upper Belgrave-street, S.W.1. Wed., Oct. 16, 6 p.m.*

Royal Meteorological Society

LONDON
"Work of Meteorological Physics Division, Commonwealth Scientific and Industrial Research Organisation, Australia," by Dr. C. H. B. Priestley. Wed., Oct. 16, 5 p.m.*

Society of Instrument Technology

MIDDLESBROUGH
"Some Aspects of Atmospheric Pollution," by C. J. Stairmand. Tees-Side Section. Cleveland Scientific and Technical Institute, Corporation-road, Middlesbrough. Wed., Oct. 16, 7.30 p.m.
NEWCASTLE-UPON-TYNE
"Remote Supervisory Control and Plant Monitoring: Printed Readout and Data Reduction," by L. S. James. Newcastle Section. King's College, Stephenson Building, Newcastle-upon-Tyne. Wed., Oct. 16, 7 p.m.

The Human Element

WASTED GRADUATES

By E. P. Kelsall, Ph.D.

A second report has now been published by P.E.P. (Political and Economic Planning) dealing with its investigation into the impact of the university graduate on industry (*Graduates in Industry*, P.E.P., 16 Queen Anne's-gate, London, S.W.1, price 30*s*.) The Group's study has been of such an intensive character that a consideration of some of the impressions which the book has produced appears to be of more value than a review dissecting and evaluating the close-packed contents and the method of inquiry. However, it should be said that the inquiry was careful and that the book provides much that is useful. Employers who have not employed graduates would do well to read it. So would those employers who have employed graduates, because most of them have not employed their graduates well. For graduates entering industry the book will be a useful preparation on what to expect, and on how to choose an employer and chart a course. Graduate engineers would do well to supplement it by obtaining the transcript of a talk on "The Graduate and the Professional Engineer," by Mr. F. Nixon, of Rolls-Royce Limited, to graduates of Nottingham University, which he delivered on June 20 last. Mr. Nixon made some telling points, which bring out the graduate's responsibility in employment.

For the past year or so, the author's company, Management Selection Limited, has been selecting managers for industry, and from this work several important points had been brought home to us. First, the importance of the man to the company: whether he be works manager, sales manager, chief engineer, financial controller, technical director or managing director, high quality in the man selected is crucial to the long-term, and sometimes to the short-term, success of the business. Secondly, that it is difficult to get a clear specification, either of the job the man will do or the man required to do it. The contrast between this position and the precise specifications which are usual for machines, equipment, building or components is sharp. Admittedly it is more difficult to specify a job or a man than a machine, but it is also obvious that much less thought and time has been given to the task.

The P.E.P. report brings out the same relative lack of thought and purpose. Six out of every ten graduates were selected after only one interview; and while most managements were satisfied with the methods used, the impressions of the graduates selected show up some of the system's deficiencies. How many engineer managers would buy a machine on such a limited showing?

One of the more surprising, and perhaps disturbing, features of this selection by one interview—with its subsequent turn-over in employment—is that, on balance, the firms which employ graduates at all are the more progressive ones. In addition the graduates themselves are, from a national standpoint, expensive products and cannot quickly or easily be replaced. One would perhaps have expected, in view of this fact, even greater care than usual; particularly as, inevitably, the possibility of error is greater because picking potential skill is always more difficult then picking people who, by experience, have demonstrated their practical ability. Nor would such firms neglect the running-in and adjustment of machines to get over teething troubles and on to maximum loading as soon as possible. From the chapters on introduction to the firm, and training it may be seen that the treatment of an expensive investment in human ability and resources is much less careful and complete.

The analogy with machines is chosen deliberately and with apologies only to the graduates. The report has let companies and managements off lightly. The graduate must be seen in his proper perspective as part of the human resources available to industry, and human resources must be seen in their proper perspective as the most important components of a company's strength, without which, machines, organisation, materials, and methods will fail.

In the considerable number and variety of industrial concerns which have been studied by Management Selection Limited during the past year or so, material resources, by and large, are not used badly. There is not much waste and they study costs, planning, methods, stocks handling, and so forth. The picture is very different with human resources. It is not uncommon to find a top man's desk littered with problems which he should never have to see, while his subordinates are crying out for more scope and responsibility. The answer is simple and confers benefits both ways: the top man gets time to think and his subordinates have the opportunity to deploy and develop their own ability. Patterns of poor delegation tend to be repeated all down the line and there are wasted assets all the way. Anyone who has seen what human beings can do in an emergency will realise the extent of the waste and the competitive advantage accruing to the firms who give these assets expression.

The graduate is an obvious source of unused ability. He tends to become more useful at the higher levels, provided he has had the kind of preparation at the lower levels that makes him a good manager of people. He will not object to this preparation, providing that its usefulness is explained to him and he sees it as efficient and purposeful. If he is not given scope, he becomes disgruntled or leaves, and it is significant that 43 per cent. of graduates had left their employers by the time that the P.E.P. survey touched them. Wastage of graduate manpower is comparable then to having an expensive machine and not using it and, to engineers, there will be no need for a more potent illustration.

Continuing **The Human Element**

Experience for Government Scientists

The staffing of the Atomic Energy Authority is causing trouble. In several instances this year difficulties have been experienced by senior people on transferring from the Civil Service to the A.E.A. The October issue of *State Service*, the journal of the Institution of Professional Civil Servants, describes the case of two senior officers in the Admiralty who were refused transfers. One of these was in the Directorate of Electrical Engineers and the other in the Royal Corps of Naval Constructors. Both, in fact, went over to the Authority, but in so doing lost the superannuation benefits earned for their Admiralty service.

One of the two officers concerned gave a substantial part of his Civil service in the Post Office and moved into the Admiralty carrying his superannuation credit. Now he loses it not only for his Admiralty service but for his Post Office service as well. As no action can be taken on a matter such as this within the Civil Service, the chairman of the National Staff side, Mr. Douglas Houghton, M.P., is raising it in the House.

Why Government departments should make it difficult for staff to transfer to the A.E.A. is not clear. Movement from post to post, and even from department to department, is very much in the tradition of the Service and has proved a source of great strength. A great deal of this kind of thing will be needed, particularly on the Admiralty's part, if the A.E.A. is to contribute fully to the development of atomic power for submarines and surface ships. To quote *State Service*, "this seems to be a gross example of a department acting against the best interests of the country."

Inflation Über Alles

It is a pity that King Canute was pressed to his sovereign edict on the sea: his lesson would have been so much more valuable a thousand years later when kings and commoners alike try to keep back the flood of inflation by words instead of deeds. The latest example of disillusion in this respect is an interesting one, no less than Dr. Erhard, the German Minister of Economics.

Dr. Erhard is, perhaps, the most successful post-war finance minister in Europe. He has grasped more nettles with courage and clear-headedness than most of his opposite numbers in other countries. Perhaps his success has been his undoing. He has certainly appeared to under-estimate the inflationary force of full employment.

Last week, he expressed indignation that the Ruhr coal industry should raise its coal and coke prices by 7·5 per cent. without consulting him. The move is clearly an affront to German administrative tidy-mindedness and a failure of German industrialists to march in step with the Government at Bonn. The end of the post-war honeymoon between German Government and industry may therefore be in sight. That is significant enough, but beyond it lies the fact that even Dr. Erhard cannot command inflation to cease by words without deeds.

Go West, Young Man

The exploits this summer of the Oxford Canada Club have received a good deal of publicity. This club was organised to develop interest in Canada and some 70 of its members and friends returned two weeks ago from a vacation in the Dominion. It seems that about 25 per cent. of those who went are thinking of emigrating there in due course. All, or nearly all, took jobs while they were out there with varying rates of pay, a few at very high levels of remuneration on piece rates.

It is difficult to assess what the impact of experiences of this sort are upon people. On the whole it is the enterprising who go off on such trips and it is the enterprising who on the whole provide the immigrants. On the one hand, the undergraduates have seen the country and the people. They have seen that jobs can be had but that they do not lie around for the picking up. They have experienced the high cost of living. One thing they have not been able to do and that is practise their profession or its equivalent in the environment which they will have to become accustomed to if they emigrate. Many will have enjoyed a hospitality which may not be so easily available once they settle down in their new country.

These kinds of exploits say much less about emigration than about the people who have undertaken them. They indicate a sense of enterprise which is badly needed and suggest that the old cry of "Go west, young man" can still stir those who want to "get on" in a new environment.

Promoting Local Skills

The problems of a company setting up a factory in an area where no similar industry exists were discussed in a paper issued by Hoover, Limited, entitled "The Men and Women behind the Machines." When a large new factory was built at Merthyr Tydfil to make washing machines, most of the key managerial staff were brought down from the Perivale factory. One of the first steps was to start training courses to enable local people to acquire the skills needed for promotion. The company put into operation a special scheme for apprentices in trades such as toolmaker, machine-tool fitter and maintenance electrician. Another scheme was promoted to increase the supply of mechanical, production and electrical engineers; one of their five years of training is spent at Perivale and some time is often spent at a Continental factory "as a broadening experience." The practical training is based on a training school Hoover established at Merthyr.

Among the courses being followed are those leading to the City and Guilds Institute's examinations in various technologies and to the National Certificate in Engineering. The annual intake of apprentices has recently been increased from 12 to 18 and may go up to 24 next year. This will mean that over 100 apprentices, nearly all of them from South Wales, will be at various stages of training in a few years time. In addition, the company are proposing to arrange for two boys each year to study for their diploma of technology by means of a four-year "sandwich" course with six-monthly courses at the Welsh college of Advanced Technology in Cardiff. Full-time courses at universities can be secured by outstanding pupils and there is also a graduate-apprentice training scheme in operation. In this manner Hoover hope that they have tapped a good source of local skill and enterprise.

Leadership in Technical Education

The new Minister of Education, Mr. Geoffrey Lloyd, had a scientific education, and is the first to come to the job with such a background. In a recent public statement at the opening of the Brunel College of Technology, Acton, Middlesex, Mr. Lloyd left no one in any doubt concerning the likely impact of his training on his attitude to scientific and classical studies, respectively: "I detest the false antithesis between scientific and classical learning; I do not know which extreme would be the worst: legions of godless technicians, or crusted classics retreating from the atomic age behind a battery of Latin tags."

Mr. Lloyd went on to speak of the Butler Act as "the most fundamental social reform of the Twentieth Century," pointing out that it had removed all barriers to opportunity. The educational reforms under the Act will, in his opinion, serve to remove the class divisions that remain and will produce a "governing class" drawn from every section of the community.

The Brunel College is the first major new technical college building to be completed since the publication of the White Paper describing the £100 million Government plan to increase the nation's technical education facilities. The goal of these new colleges is to produce what Mr. Lloyd described as "leaders of a new kind, highly qualified in the most advanced technologies, yet able to inspire the technicians and workmen around them." The use of the sandwich course —"a peculiarly British blend of theoretical study on the one hand and down-to-earth practical training on the other"—should make sure that the large numbers of technicians and craftsmen required to back up the technologists will be available.

Weekly Hours of Work

In the September issue of the *Ministry of Labour Gazette*, information is given which makes it possible for changes in the weekly hours of work to be calculated over a range of industries. There is now an official index showing changes in weekly hours of work, and movements in this index, taken with the well-known index of wages, makes it possible to follow changes in hourly rates of wages.

An index of this kind is particularly important from now on. There is plenty of evidence that the attention of organised labour is turning increasingly towards hours of work. Broadly, the unions are mounting a drive to lower the average working week by the elimination of overtime without reducing the earnings of their members. That being so, it is important to get the facts right and to have some readily available means of checking the movement of hours over a period of years along with wage rates and earnings.

Films and the School Leaver

A useful series of articles in the August issue of *Scientific Film Review* deals with the problem of recruitment and vocational guidance of the young. They draw attention to a number of points which must be considered before anyone decides to use films for these purposes.

Initially, they emphasise the difference between recruitment and vocational guidance. They have also a good deal to say about the dangers of "over-selling" by films which are a medium naturally suited for "dramatic" or "glamorous" treatment. The camera may never lie but it can make a sow's ear look remarkably like a silk purse. The series, which includes an article by Lord Coleraine, chairman of the National Youth Employment Council, concludes with a summary of a memorandum put out by the Central Youth Employment Executive of the Ministry of Labour. It gives a useful list of criteria by which such films should be judged.

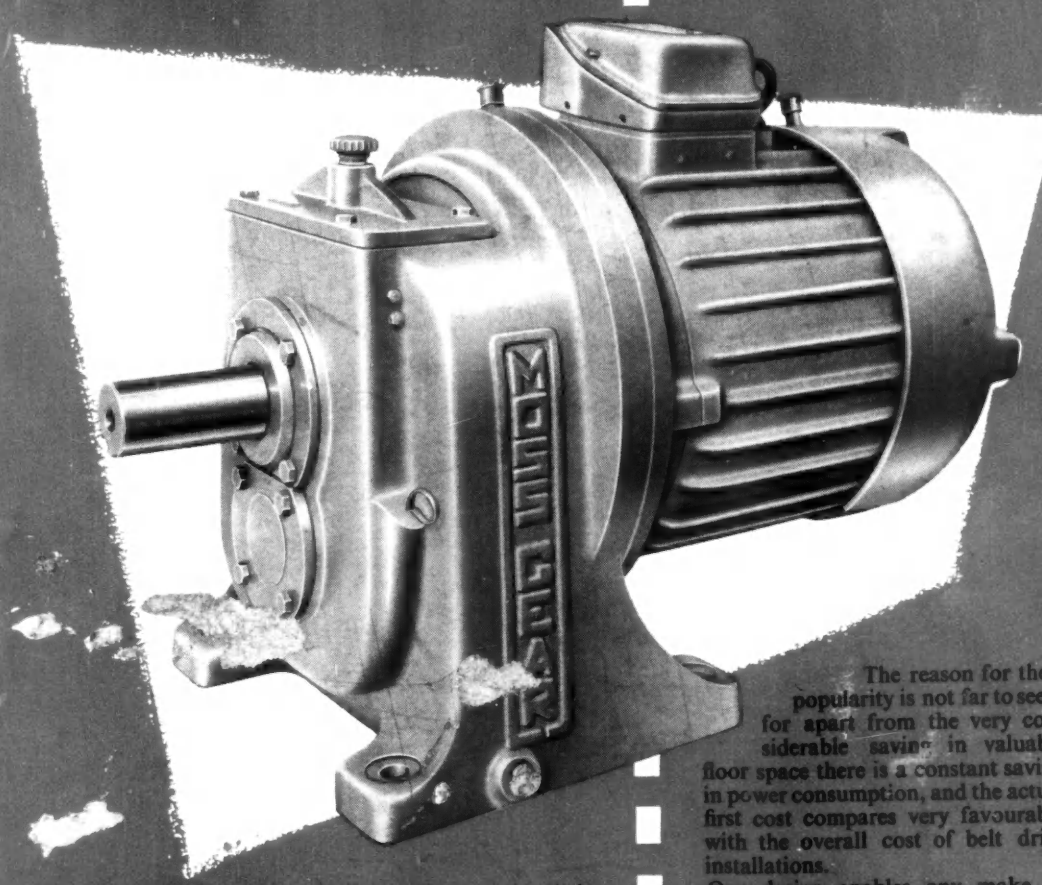
In this age of full employment, vocational guidance has an important part to play in avoiding the age-old problem of how to avoid putting square pegs in round holes. It is a difficult exercise involving the dissemination of information and an actual educative effort. Its aim must be to get the pegs in the right places where they will fit (but not completely, or the pegs will never learn to make adjustments and compromises with their environment). These are difficult terms of reference for any visual technique to accept and make a contribution towards fulfilling.

ENGINEERING

An Illustrated Weekly Journal

* save on space!

* save on cost!



Geared Motor Units are to-day largely superseding belt drives for line shafting, individual machine drives and conveyor drives; many existing drives have already been converted, and wherever new plant is being installed the integral gear and motor power unit receives first consideration.

The reason for their popularity is not far to seek, for apart from the very considerable saving in valuable floor space there is a constant saving in power consumption, and the actual first cost compares very favourably with the overall cost of belt drive installations.

Our design enables any make of flange mounting motor to be fitted. Full technical specification sent on request.

THE MOSS GEAR CO. LTD., CROWN WORKS
TYBURN, BIRMINGHAM 24

Phone: ERDington 1661-6 · Grams: 'Mosgear, B'ham'

MOSS GEARS

GEARED MOTOR